DRAFT

ER000153

Integrated Mercury Contamination Remediation Plan for the Oak Ridge Reservation

Draft 2

INTERNAL USE ONLY

CAUTION

This document has not been given final patent clearance and is for internal use only. If this document is to be given public release, it must be cleared through the site Technical Information Office which will see that the proper patent and technical information reviews are completed in accordance with Energy Systems Policy.

MCB 3/16/93

OAK RIDGE K-25 SITE DOCUMENT RELEASE FORM

Rec'd K25CO 3/11/93 c: Gretchen Bruce via Scott, File-K25CO-RC(4710)

AS Quist, 3/11/93

Person requesting release: Gretchen Bruce Telephone No. 510-748-5630

Mailing Address: 1135 Atlantic Ave. Alameda CA 9450 Division or Organization: ChemRisk

Date by which release is required: 3/12/93 (Standard processing time is 5 working days. Some documents require special review and the processing time will be longer).

Note: Two copies of the document must generally be provided to the Classification and Information Control Office with this request. Only one copy of photos and videotapes is required. Documents that include photos must be accompanied by "originals" of the photos.

Approval of request for Classification and Information Control Office to release document (department head or higher):

Signature: Gretchen Bruce Date: 2/26/93

DOCUMENT DESCRIPTION (to be completed by requester)

Document number: ES/DO-001 Pages: ____

Document title: Integrated Mercury Contamination Remediation Plan for the Oak Ridge Reservation

Author(s) (indicate other divisions or organizations, if applicable): ____

Document type (See Doc. Prep. Guide, Chs. 1 and 2, for definitions of document types):

☐ Formal Report ☐ Progress Report ☐ Informal R&D Report ☐ Abstract ☐ Drawing
☐ Administrative ☐ Correspondence ☐ Internal Technical Data ☐ Photo ☐ Other Visuals
☐ Journal Article (identify journal): ____
☐ Oral Presentation (identify meeting, sponsor, location, date): ____

Will oral presentation be published in program, booklet, brochure, etc.? ☐ Yes ☐ No ☐ Not Known

Will copies of the oral presentation be distributed ☐ before, ☐ after, ☐ during the meeting? ☐ No distribution will be made

☐ Other (specify): ____

Purpose of release: ____

Previously cleared documents containing similar information: ____

Is copyrighted material contained in this document? (If present, attach release.) ☐ Yes ☐ No

Remarks: ____

CLASSIFICATION INFORMATION (to be obtained by requester)

Was the work reported in this document funded, in whole or in part, by a classified program at Martin Marietta Energy Systems, Inc.?

☒ No ☐ Yes (Name of program: ____

Is the subject area of this document closely related to a prior or current classified program at Martin Marietta Energy Systems, Inc.?

☒ No ☐ Yes Within the Department of Energy? ☒ No ☐ Yes

Name or Description of applicable program(s): ____

Additional remarks: ____

This document contains no classified information.

Derivative Classifier signature: C. W. Kimbrough Date: 3/16/93

CN-8711 (7-91)

DISTRIBUTION LIMITATIONS (If any) (completed by requester)

☐ Unrestricted, unlimited

Distribution may be limited because this document contains information that is:

☐ Unclassified Controlled Nuclear Information *
☐ Naval Nuclear Propulsion Information *
☐ Sensitive Nuclear Technology *
☐ Safeguards Information *
☐ Applied Technology *
☐ Gov't Confidential Commercial Information *
☐ Small Business Innovation Research *
☐ Cooperative R&D Agreement *
* Generally identified by sponsor
☐ Export Controlled *
☐ Proprietary
☐ Official Use Only
☐ Other

Remarks:

PATENT INFORMATION (completed by requester)

Does this document disclose any new equipment, process, or material? ☐ Yes ☐ No

If yes, list the patent significance and identify page number(s) and line number(s) in the space immediately following (or attach separate pages).

PATENT SECTION ACTION (completed by Patent Section upon request by the Classification and Information Control Office)

☒ Document may be released for publication
☐ Document must be reviewed by DOE Patent Group before release
☐ Document contains patentable information and may not be released at this time

Remarks

Patent Section Representative A S Quist for PatentSect Date 3/11/93

CLASSIFICATION AND INFORMATION CONTROL OFFICE ACTION (completed by Classification and Information Control Office)

Classification Office Action Taken:
☒ Not approved for release (see below)
☒ Approved for release ~~without change~~ See below
☐ Approved for release with changes (see below)

Approved for ORNL & K-25. Needs Y-12 review

Classification Officer signature A S Quist Date 3/11/93

Technical Information Office Action Taken:
☐ Not approved for release (see below)
☒ Approved for release ~~without change~~ See below
☐ Approved for release with changes (see below)

Approved w/r to K-25. Needs Y-12 review

No Y-12 CLASSIFI[illegible]
M. Thaxen 3/16/93

Technical Information Officer Signature A S Quist Date 3/11/93

Send to OSTI? ☐ Yes ☒ No

Category Distribution:

UCN-87 BACK

DRAFT

Rep. Num.

Integrated Mercury Contamination Remediation Plan for the Oak Ridge Reservation

Draft 2

Decontamination and Decommissioning Program
P.O. Box 2003
Oak Ridge, Tennessee 37831-7298

Date Issued—June 1991

Prepared for
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
under budget and reporting code EW 20

MARTIN MARIETTA ENERGY SYSTEMS, INC.
managing the
Oak Ridge National Laboratory
Oak Ridge K-25 Site
Oak Ridge Y-12 Plant
Paducah Gaseous Diffusion Plant
under contract DE-AC05-84OR21400
and the
Portsmouth Gaseous Diffusion Plant
under contract DE-AC05-76OR00001
for the
U.S. DEPARTMENT OF ENERGY

DRAFT

CONTENTS

ACRONYMS

ADS	activity data sheet
BMAP	Biological Monitoring and Abatement Program
BFI	Browning Ferris Industries
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	decontamination and decommissioning
DOE	Department of Energy
DOE-OR	DOE Field Office, Oak Ridge
EFPC	East Fork Poplar Creek
Elex	electric exchange
EPRI	Electric Power Research Institute
ER	Environmental Restoration
FSs	Feasibility Study
HSWA	Hazardous and Solid Waste Amendments
HS&E	Health, Safety, and Environment
LWA	Lee Wan & Associates
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
OTD	Office of Technology Department
Orex	organic exchange
PIDAS	Perimeter Intrusion Detection Assessment System
PCBs	polychlorinated biphenyls
QA	quality assurance
ROD	Record of Decision
RMPE	Reduction of Mercury in Plant Effluents
RA	remedial action
RIs	remedial investigations
R&D	research and development
RD&D	research, development, and demonstration
RCRA	Resource Conservation and Recovery Act
SAIC	Science Applications International Corporation
S&M	surveillance and maintenance
TSCA	Toxic Substances Control Act
WAG	Waste Area Grouping

EXECUTIVE SUMMARY

The executive summary will discuss the overall program and schedule (see master ule on following page).

1. INTRODUCTION

During the 1950s and 1960s, the DOE Field Office, Oak Ridge (DOE-OR) was responsible for the DOE production of nuclear materials. Elemental mercury was used during the lithium separation process. Mercury contamination now exists on the grounds of the production plant as well in the creeks that carry runoff water from the site. This contamination was due to process loss, spills, and normal process consumption. Today, none of the processes uses mercury, but some of the shutdown facilities still contain significant amounts of mercury. Efforts are now focused on restoring and remediating these contaminated sites, including East Fork Poplar Creek (EFPC), which runs through the city of Oak Ridge.

1.1 OBJECTIVES

The objective of this document is to develop a comprehensive and integrated plan to address the various programs that are dealing with the restoration and remediation of mercury-contaminated sites.

1.2 GOALS

The overall goals of this plan are (1) to coordinate each program and the diverse technical efforts and individual program developments into a total program and (2) to identify and correct interaction or interface problems to maximize the remediation efficiency and effectiveness. The plan is to develop a forum where technical performance measurement issues can be discussed (1) to provide visibility of actual performance to schedules and cost, (2) to allow early detection or prediction of technical problems requiring management attention, and (3) to support the impact of each element of the total program upon the others. Project goals include the aggressive cleanup of lower EFPC in the city of Oak Ridge and maintaining the Record of Decision (ROD) on schedule. The project will also minimize the migration of mercury out of the buidings at the Oak Ridge Y-12 Plant site, through the run-off areas, and off the reservation by pursuing the reduction of mercury in plant effluents and the mercury use areas remedial action (RA). The planning of actual decontamination and decommissioning of Building 9201-4 (Alpha 4) will be aggressively pursued. As an essential part of the plan, we will identify and plan the technology development required to support these activities.

To achieve these goals, we believe that the best strategy will be to continue with the lower EFPC RA as scheduled and to accelerate the reduction of mercury in plant effluents schedules for Buildings 9201-2, 9201-5, and 9204-4 to eliminate mercury sources. Case 1 funding for Building 9204-4 must also be maintained, while a program is actively being planned and appropriations for decommissioning are being pursued. The cleanup activities at other mercury-use areas, such as Building 81-10, should be maintained.

1.3 SCOPE

The plan outlines all major programs identified in the DOE 5-year planning schedule. This plan integrates all current mercury abatement programs, addresses decontamination and decommissioning (D&D), integrates the biological monitoring and off-site environmental restoration (ER) activities, documents known remedial technologies, outlines future technology needs, and develops a management structure for the implementation of the program.

1.4 DEFINITIONS

Need text

1.5 BACKGROUND

Need text.

1.6 ASSUMPTIONS AND UNCERTAINTIES

1.6.1 Assumptions

The following assumptions are made:

- The plan has been developed using input from the DOE 5-year planning criteria.
- The plan focuses on the 30-year ER commitment.
- Technology development plans are not currently in the 5-year plan.
- Milestones and program commitments are based on Case 1 funding as defined in DOE criteria and guidelines.

1.6.2 Uncertainties

Program commitments will change as programs become mature and as the funding allocations change annually to meet the increased customer needs. The development of technologies is a critical part of the success of any of these programs. This plan will identify technology that will be required to remediate these contaminants as well as provide a DOE-wide focus for other sites in the system.

2. MANAGEMENT STRUCTURE/ROLES AND RESPONSIBILITIES

Prior operation of DOE facilities on the Oak Ridge Reservation (ORR) has caused buildings, plant areas, and off-site locations to be contaminated by mercury. Various programs within the DOE ER Program are responsible for monitoring, investigating, and eventually cleaning up individual areas of contamination. The programs involved include the RA programs for each of the three DOE-OR plant sites, the D&D programs for each of the three plant sites, the off-site RA program, and other support programs.

The ER division director has appointed a Mercury Restoration Program integration manager to integrate the various individual programs. While the individual program managers will continue to be responsible for the planning and execution of their individual programs, the integration manager will be responsible for the formulation of overall strategies, the definitions of interfaces between programs, integrated consistent budgeting, technology exchange, and development and completion of overall programmatic milestones.

The descriptions of the responsibilities for the individual programs are shown in the following sections of this chapter. An organization schematic for the overall program, showing each individual program, is shown in Fig. 2.1.

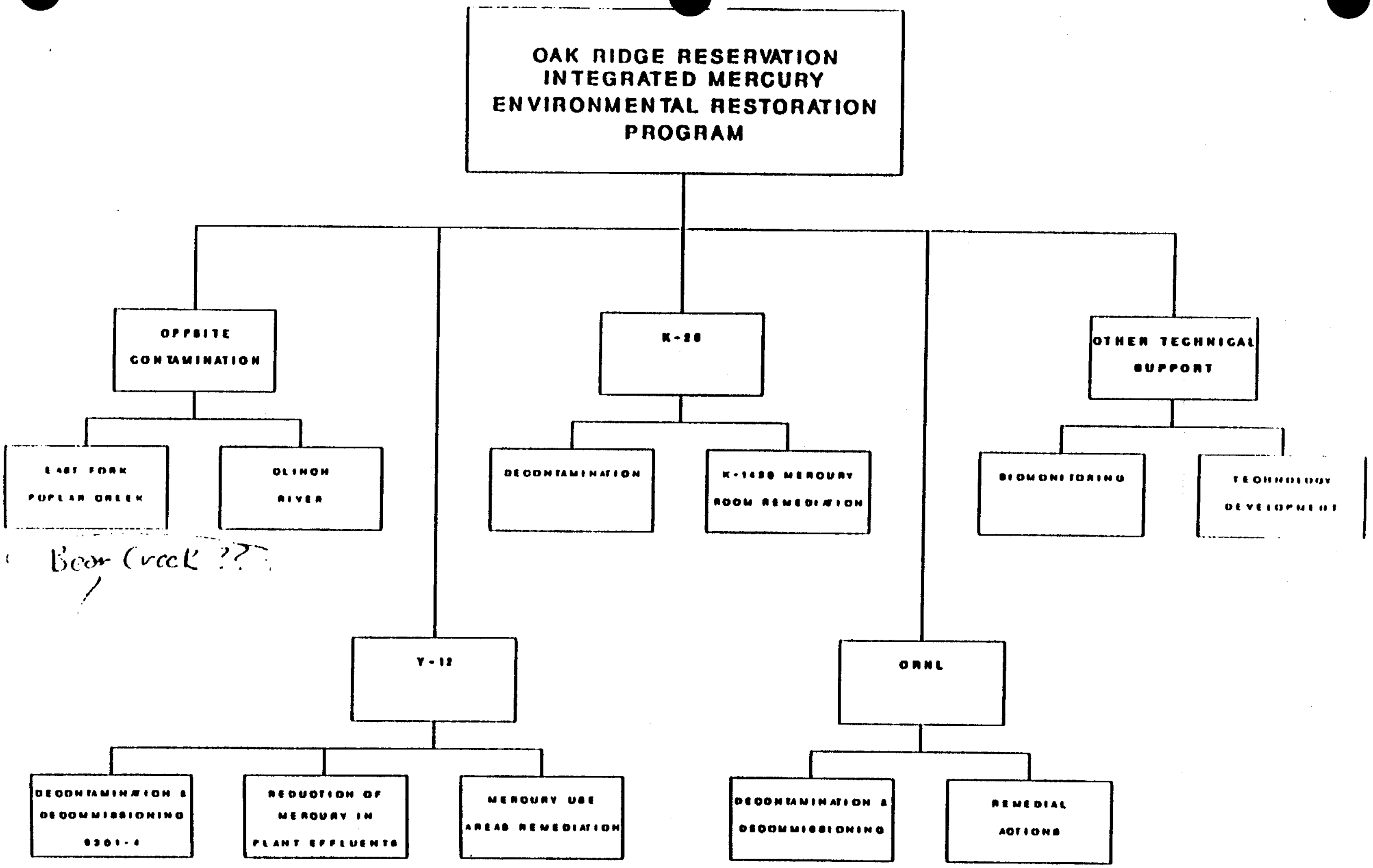

Fig. 2.1 Oak Ridge Reservation Integrated Mercury Environmental Restoration Program.

2.1 OFF-SITE CONTAMINATION

Two major areas of mercury contamination are EFPC, in the city of Oak Ridge, and the Clinch River. Both creeks are adjacent to or run through parts of the ORR.

2.1.1 East Fork Poplar Creek

Lee Wan & Associates (LWA), a prime contractor to DOE, is responsible for the remedial investigations (RIs) of EFPC. Science Applications International Corporation (SAIC) is a subcontractor to LWA on this effort. Together they are performing the analysis, feasibility studies (FSs), and FS cost comparisons and recommending a preferred alternative for the ROD.

2.1.2 Clinch River/Watts Bar Reservoir

The Clinch River/Watts Bar Reservoir System is contaminated with various radionuclides and polychlorinated biphenyls (PCBs) in addition to mercury. The RI of the Clinch River is being done by the Energy Systems ER Division and supported by the Oak Ridge National Laboratory (ORNL) Environmental Services Division. The FSs, alternative comparisons, and selections of preferred alternative(s) for the ROD will be done by LWA.

2.2 OAK RIDGE Y-12 PLANT

The Y-12 weapons production plant has been by far the largest contributor historically to mercury contamination both on and off the ORR. The following programs are addressing mercury contamination in Y-12.

2.2.1 Decontamination and Decommissioning

Building 9201-4 (Alpha-4) was used for the Colex process to separate lithium isotopes. Tons of mercury were used in this process, which was shut down in the 1960s (December 1962). It is thought that the building still contains over 50,000 lb of drainable mercury still. The exhaust ventilation system is being operated to minimize fugitive emissions of mercury. The building is currently being maintained and surveyed by Y-12 Plant personnel as part of the Y-12 D&D program. Energy Systems is responsible for current activities in 9201-4 and the planning for eventual decommissioning.

2.2.2 Reduction of Mercury in Plant Effluents (RMPE)

The RMPE is part of the Y-12 RA program and is the responsibility of the Energy Systems ER Division. The RMPE will selectively reroute storm water systems, clean out building sumps, and remove some mercury-contaminated facilities in Building 9201-2 (Alpha-2) and some other areas of Y-12.

2.‹ Mercury Use Areas Remediation

The Y-12 RA program consists of the remediation of various mercury use areas, including Buildings 9202, 9201-2, 9201-4, 9201-5, 9733-1, 9733-2, and 81-10, and is the responsibility of Energy Systems ER Division.

2.3 OAK RIDGE K-25 SITE

While the degree of mercury contamination at the K-25 Site is small relative to that at Y-12, two areas are part of this program: D&D and the K-1420 mercury recovery room.

2. Decontamination and Decommissioning

Some of the instrumentation in the K-25 process buildings includes thousands of mercoid switches. They are enclosed and not dangerous to human health and the environment presently, but during D&D their removal and disposal will be considered part of the integrated mercury planning. K-25 Site D&D personnel are responsible for this portion of the work.

2.3.2 K-1420 Mercury Recovery Room

Building K-1420 was once used for mercury distillation. The remediation of this area is the responsibility of the K-25 RA Program, which is part of the Energy Systems ER Division.

2.4 OAK RIDGE NATIONAL LABORATORY

Like K-25, mercury-contaminated areas at ORNL are relatively small compared with those at Y-12.

2.4.1 Decontamination and Decommissioning

D&D of surplus contaminated facilities at ORNL is the responsibility of the on-site D&D Program as conducted by the ORNL Office of Waste Management and Remedial Action. Facilities contaminated with residual quantities of mercury will undergo D&D as part of this effort. Several ORNL facilities have the potential for mercury contamination as outlined in Sect. 3.4. Contamination resulting from leaks or spills beyond the confines of physical buildings will be managed by the ORNL on-site remedial action program (Section 2.4.2). In addition to these activities, residual contamination in the lower confines of ORNL facilities at Y-12 will be cleaned up as part of the RMPE (Sect. 2.2.2).

2.4.2 Remedial Action

The on-site mercury abatement at ORNL is organized in a remediation plan, which has identified several sites in Waste Area Grouping (WAG) 1. The remediation plan will address the mercury contamination at Buildings 4508, 4501, 3592, and 2503. Mercury sediments in the drainage areas will also be addressed.

2.5 OTHER TECHNICAL SUPPORT

The other support described in this section is not for particular cleanup programs per se, but for programs that support some or all of the cleanup programs. This section also describes the role of the DOE construction manager and the ER Waste Management architect–engineer.

2.5.1 Biomonitoring

Approval of the National Pollutant Discharge Elimination System (NPDES) permit for the Y-12 Plant was contingent on implementation of a biological monitoring program for EFPC. The Y-12 Biological Monitoring and Abatement Program (BMAP) was designed (1) to provide sufficient data to demonstrate that the effluent limitations established in the permit protect and maintain the classified uses of the stream and (2) to document the effects of the Y-12 Water Pollution Control Program on stream biota. Similar biomonitoring programs have been implemented in support of NPDES permits at ORNL and K-25.

2.5.2 Technology Development—Waste Research and Development Program

Technology development is generally coordinated and/or managed under the auspices of the ORNL Waste Research and Development (R&D) Program. The mission of the Waste R&D Program is threefold: (1) to develop new technologies ("faster, cheaper, better, and safer") for dealing with the nation's environmental restoration and waste management problems and to provide technical assistance in the application of these and conventional technologies, (2) to develop waste systems and transportation analysis capabilities, and (3) to conduct site radiological surveys in the most efficient manner possible.

Roles of this group include the following:

1. Maintain cognizance of Energy Systems waste R&D capabilities and identify sponsor needs.
2. Develop research, development, and demonstration (RD&D) proposals to address sponsor needs and present to the sponsors.
3. Monitor costs, schedules, and quality of ongoing activities to ensure customer satisfaction.
4. Maintain cognizance of related activities at other DOE sites and within the commercial community and seek collaborative activities whenever possible.
5. Develop short- and long-range strategies for the Waste R&D Program.

Responsibilities include the following:

1. Discuss waste R&D capabilities with appropriate division directors and research staff, and review division, laboratory, and plant reports.
2. Discuss waste R&D needs with DOE staff, Energy Systems Environmental Restoration and Waste Management staffs, and HAZWRAP staff.
3. Participate in meetings, workshops, conferences, and personal contacts and encourage staff to do likewise.
4. Conduct workshops and solicit RD&D proposals.
5. Perform quality assurance (QA) and process proposals.
6. Compile and edit monthly reports to sponsors.
7. Track budgets and milestones. Identify problem areas and work with staff to resolve issues expeditiously.

8. Identify possible collaborative activities with the commercial community or with other DOE laboratories.
9. Develop a Program Management Plan and Strategic Plan.

2.5.3 EBASCO Services, Inc., Environmental Restoration Architect-Engineer

Text needed.

2.5.4 Construction Manager

Text needed.

3. HISTORICAL BACKGROUND AND CURRENT STATUS

3.1 OFF-SITE CONTAMINATION

Since the early 1940s, operations and waste disposal activities at DOE's Oak Ridge Y-12 Plant, ORNL, and the Oak Ridge K-25 Site have led to the contamination of off-site locations in EFPC, Clinch River, and Watts Bar Reservoir. Contaminants include radioactive elements, heavy metals, and organic compounds.

The contaminants are carried away from each of the three plants on ORR by groundwater and surface water runoff. The contaminants are primarily transported from hazardous waste sites on the Reservation to the Clinch River by tributary streams: White Oak Creek (from ORNL), Bear Creek and EFPC (from Y-12), and Poplar Creek (from K-25). Contaminants have settled primarily in the EFPC floodplain and the Clinch River and Watts Bar Reservoir, downstream from the Reservation.

Currently, DOE is investigating the nature and extent of this contamination as part of the ER Program on ORR. Included in this program is the investigation of off-site contamination in local waterways and streams.

3.1.1 East Fork Poplar Creek

As part of its ER Program for ORR, DOE is studying EFPC. The study will include the creek, its associated floodplain, and the Oak Ridge sewer beltway where soil materials taken from the creek were used as fill. This study will determine what cleanup actions DOE will undertake there under the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The National Environmental Policy Act (NEPA) also applies.

3.1.1.1 Location

EFPC flows from the east end of the Y-12 Plant and passes through the Pine Ridge section of Oak Ridge to the west of Scarboro Road (Fig. 3.1). The creek flows behind the K-Mart shopping center and passes close to the intersection of Illinois Avenue and Oak Ridge Turnpike; then it turns westward passing near Jefferson Avenue and continuing roughly parallel to the Oak Ridge Turnpike. It is joined by Bear Creek and joins Poplar Creek near the K-25 Site, previously known as the Oak Ridge Gaseous Diffusion Plant.

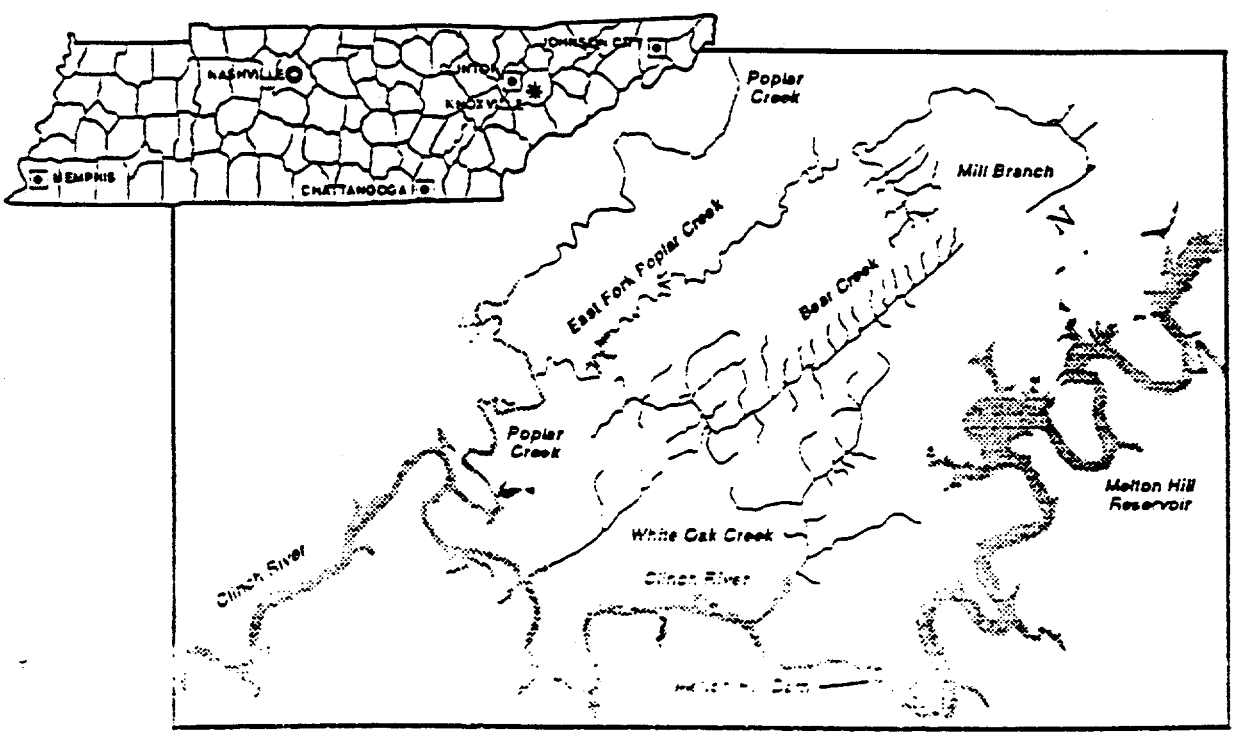

Fig. 3.1. EFPC flows from the east end of the Y-12 Plant, past the Oak Ridge community, then on to Poplar Creek.

3.1.1.2 Contamination in EFPC

EFPC has become contaminated as a result of operations and accidental releases at the Y-12 Weapons Plant. Between 1950 and 1963, mercury was used at Y-12 to separate different isotopes of lithium. Large quantities of mercury were spilled or lost. An estimated 239,000 lb of mercury were released from Y-12 to EFPC during the period 1950–1982 (Fig. 3.2). Mercury is the major contaminant found in the EFPC and the associated floodplain. Other heavy metals, radionuclides, and some organic compounds also have been found in EFPC and associated floodplain soils.

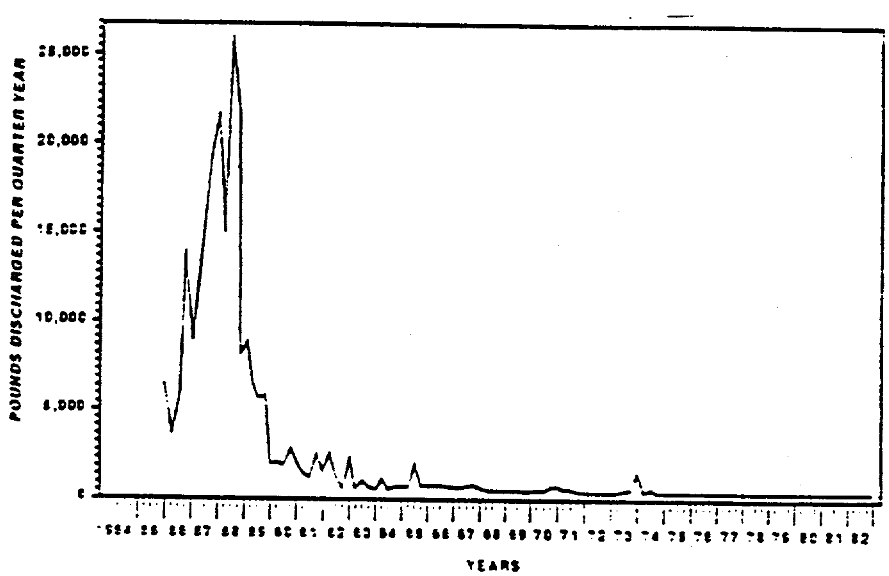

Fig. 3.2. A total of 219,000 lb of mercury was discharged into EFPC between 1955 and 1982. From 1950 through 1954, an additional 20,000 lb was released.

3.1.1.3 Past Studies . . . and the Need for More Studies

During the years 1983 through 1989, community and floodplain studies were conducted. The studies were coordinated by DOE, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the Tennessee Department of Environment and Conservation, the city of Oak Ridge, and the Tennessee Valley Authority. Sampling and analysis were conducted to determine the extent of contamination, and some contaminated soils were removed because of the possible risks. The Task Force studies indicated that the contamination in EFPC posed no immediate threat to public health. As these studies were being completed in 1987, the U.S. Environmental Protection Agency issued guidelines on how risk analyses should be done for ER actions under the 1986 amendments to CERCLA. The CERCLA process called for a rigorous analysis of risks to human health, including modeling of contaminants in the EFPC system. To support the extensive modeling studies and analysis of alternatives required by CERCLA, some additional sampling and analysis still need to be done. Other historical studies are shown in Table 3.1.

Table 3.1. EFPC—historical data summary

Source	Data type	Period of data collection
Office of Natural Resources and Economic Development, Tennessee Valley Authority	Water sampling	February–November 1984
	Sediment characterization	June–November 1984
	Fish sampling	May 1984
Oak Ridge Associated Universities	"Rapid scan" survey	1984–1985
	Soil	1983–1987
	Sediment	1983–1985
	Sludge	1983–1987
	Animal	1983, 1984, 1986
	Vegetation	1983–1987
	Water	1983, 1984, 1986, 1987
Ralph Turner (Reality Lake)	Sediment	March 1990
ORNL Remedial Action Program (BMAP)	Animal	May–September 1987
Y-12 Environmental Management Dept. (Monitoring Station 17)	Water	November 1988–December 1989
ORNL Environmental Monitoring & Compliance—Off-Site Groundwater Monitoring	Groundwater	September 1989
ORNL/TM-8894, *Mercury Contamination in EFPC and Bear Creek*	Sediment	May 1982
	Fish	May 1982
	Vegetation	May 1982

3.1.1.4 Scoping for the Environmental Impact Statement

On November 18, 1988, DOE announced that it would prepare an Environmental Impact Statement (EIS) for environmental restoration of EFPC, as required by NEPA. Following DOE's policy (DOE Order 5400.4), the EIS would be integrated with an additional requirement from CERCLA—an FS. DOE held a "scoping" meeting on December 6, 1988, and invited the public to submit comments and suggestions to assist DOE in identifying significant environmental issues and to define the appropriate scope of the EIS.

3.1.1.5 Start of the Remedial Investigation

In January 1990, DOE began the RI and FS to determine what environmental cleanup actions should be undertaken for EFPC. The purpose of the RI is to gather all existing data on the creek and perform field studies to gather new data that are needed. In order to set priorities for cleanup activities, DOE must evaluate the risks of the current conditions (a "baseline" risk assessment) and then evaluate how the risk will change under various cleanup options. The FS discussed all the alternatives that are being considered and the pros and cons of each alternative in terms of effectiveness in reducing human health risk, feasibility, costs, and compliance with applicable laws and regulations. The FS will be combined with the EIS, so that risks to the environment will also be considered.

3.1.1.6 Access to Property to Conduct Sampling

One reason that further sampling, analysis, and study is needed for EFPC is to establish the conditions in the groundwater located beneath surface layers of rock and soil. CERCLA provisions require detailed information on groundwater contamination. Groundwater in the EFPC floodplain was studied to a limited extent in the Task Force studies. More extensive studies are required under the new CERCLA guidelines. During the RI, new groundwater monitoring wells will be installed and used for sampling, and new sampling stations will be established. To facilitate the access by researchers to these study sites, DOE has negotiated property access agreements with property owners along EFPC.

3.1.1.7 Looking Ahead

During the remainder of 1990, DOE will be performing environmental sampling of the EFPC system. The work will describe how mercury and other contaminants are moving through the environment. During 1991 DOE will begin a process of screening remedial alternatives. The screening will make use of the environmental sampling data to help identify and evaluate the cleanup processes that are applicable to the contaminants in EFPC.

3.1.2 Clinch River/Watts Bar Reservoir

The Clinch River and the Watts Bar Reservoir are and have been the recipients of contaminated releases from all three DOE facilities on ORR. To help determine the size and scope of the problem, researches have studied river sediments. Sediment samples reveal a history of a contaminant's transport from the ORR. This history is contained in the sediment layers that add one upon the other, year by year, inch by inch. Heavy metals such as mercury tend to settle and flow to the deepest river channels. There they become part of the sediment, and new layers of river sediment are added. Each layer of sediment tells a story of the type of contamination, the amount, and when it happened. Scientists take core samples from different portions of the river to determine the types of contamination and to help identify cleanup alternatives.

Early results from these sampling studies have helped researchers to understand the consequences of many years of Oak Ridge plant operations. The studies show that an estimated total surface area of nearly 45 square miles of lake sediment may contain as much as 290 Ci of ^{137}Cs, and about 83 tons of mercury. Most of the ^{137}Cs and mercury contamination in Watts Bar Reservoir is found in deep water sediments in the old Clinch and Tennessee River channels. Contaminants, however, can be found in varying concentrations at other locations. The contaminants are typically found 2.5 ft deep within the reservoir sediments and are not subject to normal human contact.

These studies show that the sediment is not easily distrubed by activities on the surface of the water or by changing flows of the rivers or streams. Most of the contaminants have stayed where they settled. Mercury has not dissolved, and cannot dissolve, into the water. However, the overall contamination is being studied extensively to protect public health and the environment. These expanded efforts through the ER Program are being done in addition to the routine monitoring programs which determine water quality and the degree of contamination in fish. The results of these tests are reported in an annual environmental monitoring report, which is made available to the public.

Preliminary human health and ecological studies of the off-stie contamination show that there is no imminent risk to the environment or public health. The objective of these investigations is to determine the nature and extent of contamination, to assess ecological and human risk, and to identify potential remedial alternatives. DOE is in the first phase of the off-site environmental investigation, which looks at the potential ecological and human health risks associated with the contamination.

Three preliminary scoping studies reports on the Clinch and Watts Bar Reservoir were released in 1990:

- *Screening Level Risk Assessment for Off-Site Ecological Effects in Surface Waters Downstream of the U.S. Department of Energy Oak Ridge Rservation* (ORNL/ER-8).
- *Preliminary Screening of Contaminants in the Off-Site Surface Water Environment Downstream of the U.S. Department of Energy Oak Ridge Reservation* (ORNL/ER-9).
- *Transport and Accumulation of Cesium-137 and Mercury in the Clinch River and Watts Bar Reservoir System* (ORNL/ER-7).

Public information meetings were conducted in June 1990. The Clinch River RI Work Plan was reviewed and approved by DOE and submitted to the regulators. Phase 1 sampling and analysis was initiated in FY 1990.

If adequate funding is received to maintain an aggressive RI schedule and major changes in scope are not required, the Clinch River Remedial Investigation and the RI report should be completed by the end of FY 1996. An FS will be initiated in FY 1997 under a new activity data sheet (ADS).

Activities in FY 1991 represent the conclusion of Phase 1 and the planning for Phase 2 of the Clinch River RI. FY 1991 activities include (1) near-shore sediment characterization in Watts Bar Reservoir, (2) completion of Phase 1 analyses and data validation, (3) completion of draft Phase 1 site characterization and preliminary risk assessment report and Phase 2 sampling and analysis plan, (4) sampling and analysis for contaminants in recreational-use areas and water-supply intakes, and (5) initiation of hydrologic and sediment transport assessments.

Key assumptions underlying this schedule are that (1) no major surprises necessitating drastic increases in scope or cost will occur, (2) funding continues at requirement levels to permit an aggressive RI schedule, and (3) NEPA determination and documentation and DOE regulator review and approval of primary documents are conducted on schedule so as not to impede progress on RI/FS.

3.2 OAK RIDGE Y-12 PLANT

Between 1950 and 1963, elemental (metallic) mercury was used at the Y-12 Plant in enormous quantities to separate ^{6}Li (for use in thermonuclear weapons) from the heavier and more abundant ^{7}Li isotope. The process used at the Y-12 Plant to separate these two isotopes of lithium was based on the fact that, under certain conditions, ^{6}Li is more readily solubilized in mercury than ^{7}Li. The initial request to the Y-12 Plant for the development of a production-scale process for lithium separation was made in 1950 and work began almost immediately. An electrically driven, chemical-exchange process and an organic exchange process, known respectively as the electric exchange (Elex) and the organic exchange (Orex) processes, were developed initially and progressed as far as the construction of pilot plants. In 1953, the Elex process was taken to the production stage; a plant using the process operated for a short time in Building 9204-4. However, with the research continuing and very successful development in 1951 of a third lithium isotope separation process known as Colex, work on the Elex and Orex processes was abandoned to concentrate on the Colex separation. A major production plant expansion began in 1953, with two large Colex production facilities (i.e., Buildings 9201-5 and 9201-4) being designed and built within a period of 15 months. These production facilities were put into operation in January and June 1955, respectively, and continued operating until 1958 and 1963, respectively. Figure 3.1 shows schematically the chronology of lithium isotope separation operations at the Y-12 Plant.

Mercury releases to air and surface water and spills to soil in the plant are relatively well documented for the entire period of lithium isotope separation and subsequently. Figure 3.2 illustrates the history of mercury releases to EFPC. Estimated total releases of mercury to air, surface water, and soil are given in Table 3.2.

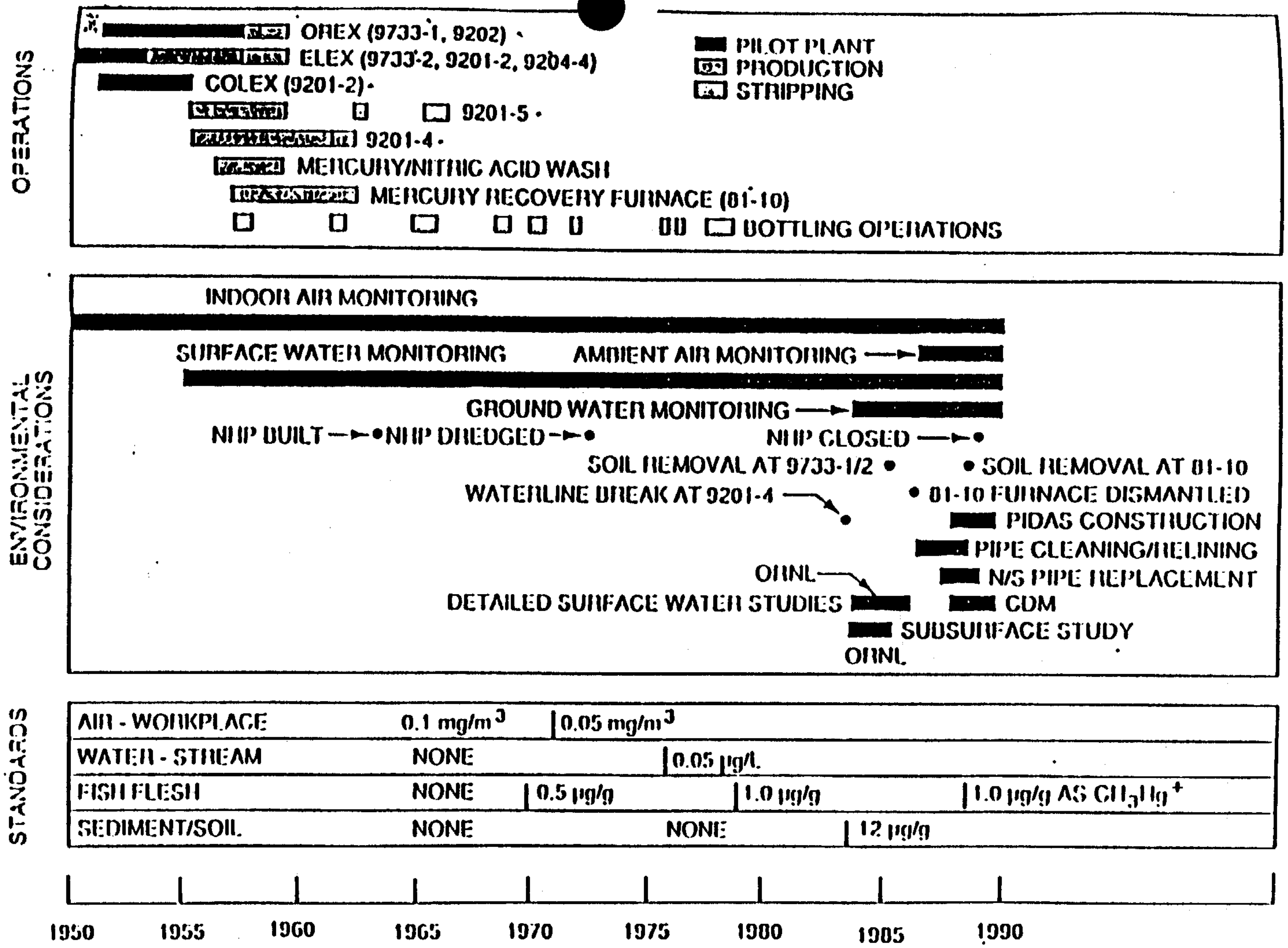

Fig. 3.1. Chronology of lithium isotope separation operations at the Y-12 Plant and related information (modified from Wilcox 1983). (DOES THIS FIGURE NEED COPYRIGHT PERMISSION?)

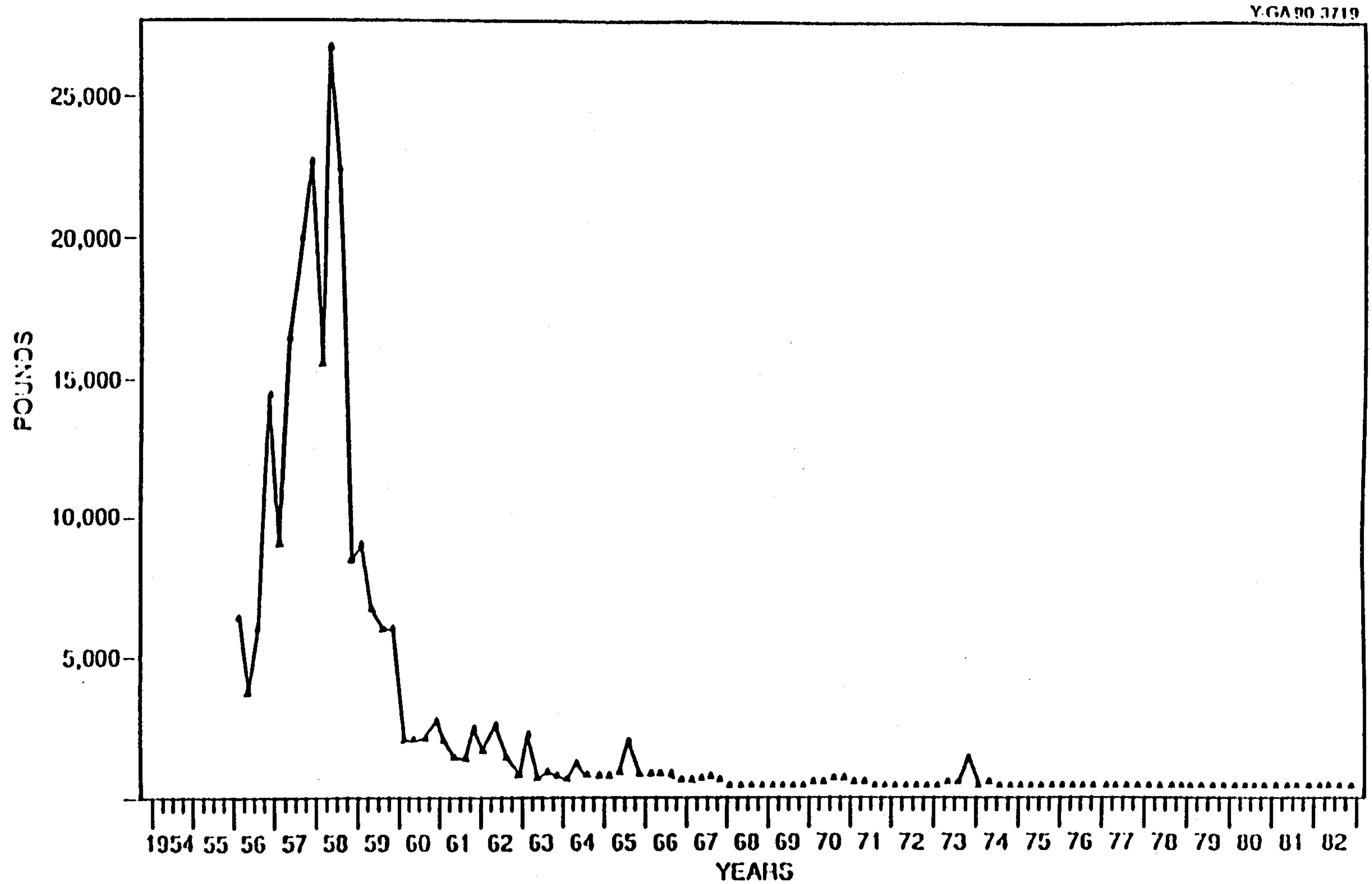

Fig. 3.2. History of mercury losses to EFPC (from Wilcox 1983). (DOES THIS FIGURE NEED COPYRIGHT PERMISSION?)

Table 3.2. Estimated total releases of mercury to air, surface water, and soil

Mercury lost	Mercury (lb)
Lost to air (1950–1963)	51,000
Lost to East Fork Poplar Creek (1950–1982)	239,000
Lost to ground under the Y-12 Plant	428,000
Lost to sediments in New Hope Pond	15,000
Not accounted for[a]	1,300,000
Total	2,033,000

[a]Difference between amount charged to lithium isotope separation program and the amount accounted for as inventory, plus the amounts lost, spilled, and dumped. Modified from Wilcox et al. (1983).

A detailed listing and description of all engineered modifications to facilities and the environment in the Mercury Use Areas is beyond the scope of this document. Buildings have been constructed, razed, and modified over the 47-year life of the Y-12 Plant; process equipment has been installed and removed from buildings; natural drainages have been obliterated by filling, rechannelization, and installation of subsurface drainage systems; soil and fill have been exported and imported from many areas inside and outside the Y-12 Plant. One large building (9103) was constructed over the former site of the mercury deflasking station for the lithium isotope separation program.

Three engineering projects carried out since 1986 are considered to be especially important in developing the RCRA Facility Investigation Plan for the Mercury Use Areas: (1) RMPE, (2) utility systems restoration, and (3) perimeter intrusion detection assessment system (PIDAS). The RMPE entailed storm sewer inspection, storm sewer cleaning, storm sewer relining using the "Instituform" process, rerouting of certain water flows, and miscellaneous other activities aimed at reducing mercury concentrations in plant drainage waters. A total of 5588 ft^3 of storm sewer was cleaned, and 8358 lin ft of storm sewer was relined. Figures 3.3 and 3.4 show the storm sewer lines that were cleaned and relined. The Utility Systems Restoration Project included replacement of a large section of the subsurface storm sewer piping in the western portion of the plant. Two 60-in. concrete pipes that had carried storm flow and plant effluents from the western area were abandoned in place and replaced in a new corridor to the north with a 90- to 108-in. concrete pipe. The PIDAS project entailed construction of a 30- to 50-ft-wide security corridor around the western exclusion area of the plant. Because of the nature of the sophisticated security system, existing soil and fill had to be excavated and replaced with clean soil of consistent properties. Soil and fill excavated from the PIDAS corridor near Building 81-10, and two other areas where high mercury concentrations were encountered, were disposed of in the Chestnut Ridge Sediment Disposal Basin before this site was closed and capped. The outline of the PIDAS corridor is shown in Fig. 3.5.

These major engineering projects were undertaken after the previous investigations of soil and surface water contamination were completed. As these projects were intended to change or inadvertently changed contaminant concentrations and distributions, they have been considered in developing the RFI plan for the mercury use areas.

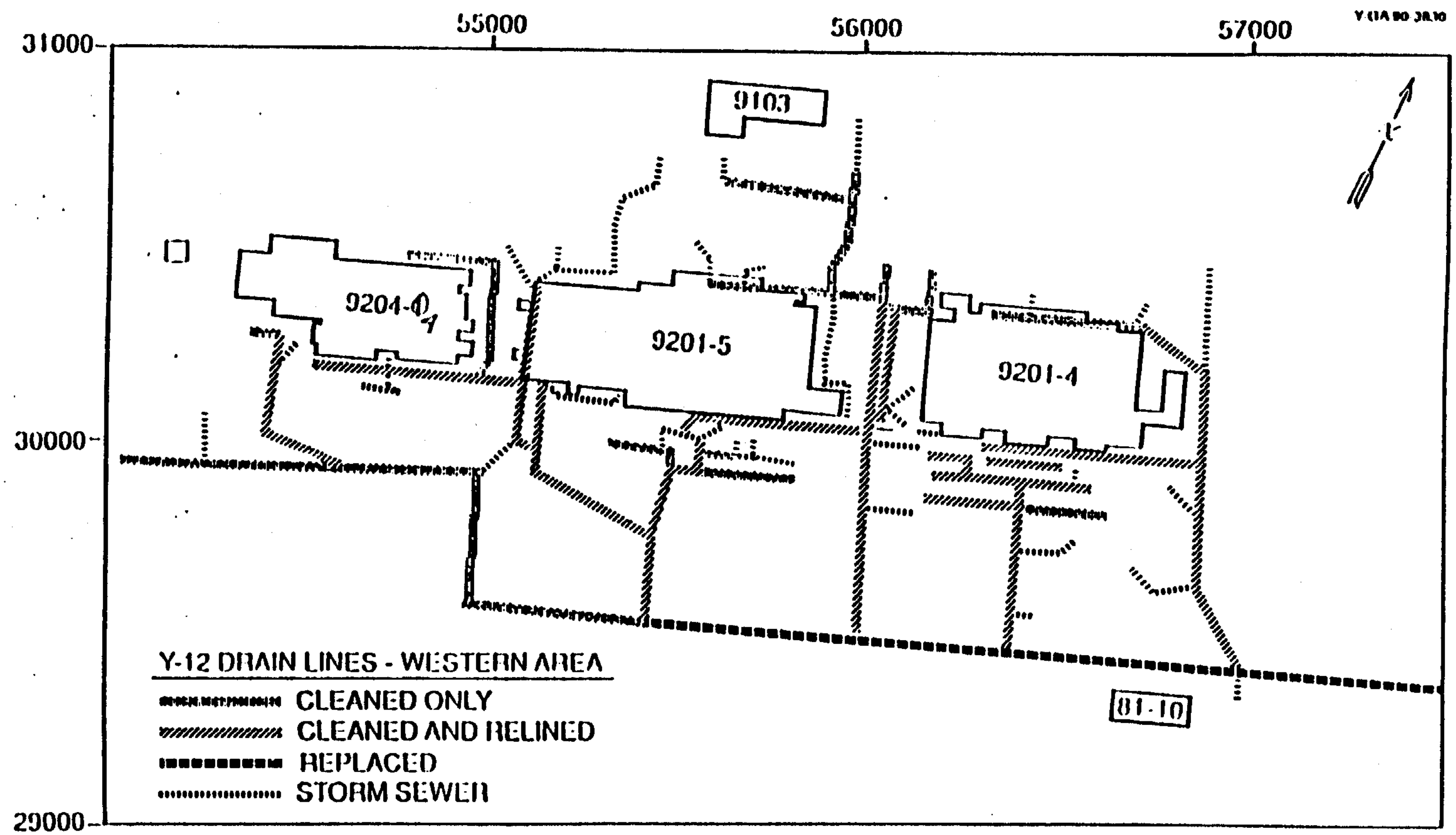

Fig. 3.3 Storm sewers cleaned, lined, or replaced in the western area of the Y-12 Plant.

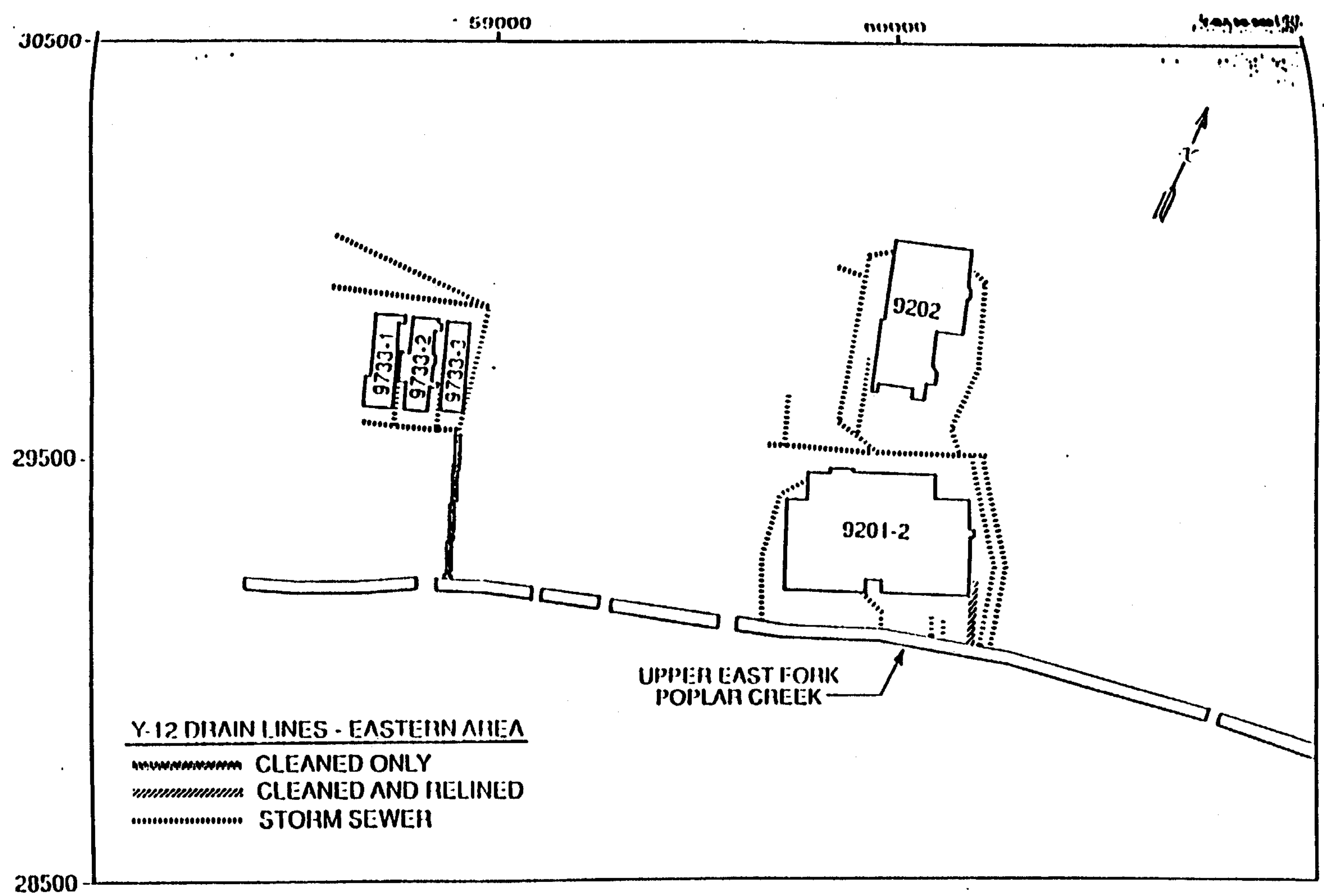

Fig. 3.4. Storm sewers cleaned and lined in the eastern area of the Y12 Plant.

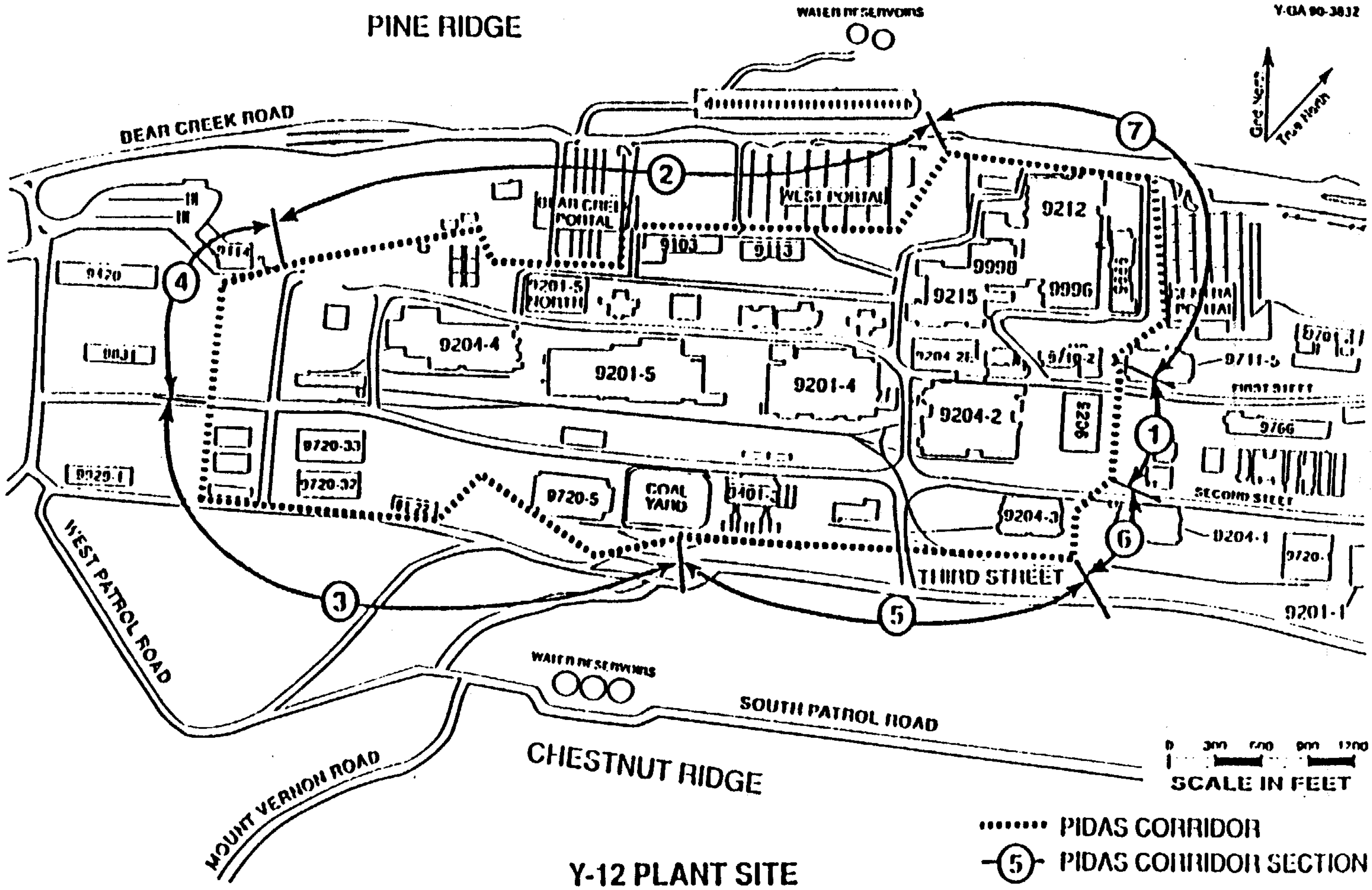

Fig. 3.5. Outline of PIDAS corridor.

3.2.1 Decontamination and Decommissioning

The plan at Y-12 is to decontaminate Building 9201-4 and equipment associated with the facility, which was operated in the late 1950s and early 1960s. The process run at the building consisted of a mercury/solvent extraction process used for lithium isotope separation (also known as Colex, which stands for column exchange). The system consists of liquid-liquid separation columns and associated pumps, piping, trays, auxiallaries, and tanks, which remain contaminated with mercury. Additionally, the building structure is contaminated with mercury from losses during operations. Estimates suggest that 300,000 lb of mercury are still in the building and on or in equipment. D&D activities will include a baseline cost estimate including regulatory requirements and waste management, a D&D plan (two to three phases such as equipment decontamination/removal, utility decontamination/removal, and structural decontamination/removal), design and specifications, waste management and waste minimization, and necessary NEPA documentation.

Various efforts in research, demonstrations, development, testing, and evaluation have been initiated to evaluate decontamination of mercury-contaminated metals, which is the primary concern from a waste management/waste minimization standpoint. Baseline cost estimates have been prepared for removal of Colex equipment and structural demolition; estimates do not include waste management or other regulatory requirements. All equipment has been drained of bulk mercury, and minimum surveillance and maintenance (S&M) continues on a daily basis (ADS 254).

The equipment should be stripped and all waste removed by the end of FY 1997. Funding for D&D planning, phasing, and NEPA documentation needs to begin in FY 1992. Four alternative activities are (1) demolish to "greenfield," (2) complete D&D as proposed in a multiphase project, (3) remove equipment only, and (4) continue routine S&M.

Funding under ADS 254 for S&M of Building 9201-4 for FY 1991 will be used to develop an S&M plan for the Y-12 Plant D&D Program. A baseline Risk Assessment and Safety Assessment will be produced to start preparing NEPA documentation in FY 1992. A baseline cost estimate with an estimated cost for waste management will be generated under ADS 254. Current S&M funding will continue in FY 1991 from GB in order to provide minimum S&M needs.

Plans to develop a D&D plan must begin in FY 1992 to avoid slippage in other schedules. NEPA Environmental Assessment cannot begin until a method is established for actual D&D efforts.

All waste can be stored in Alpha 4 until a strategy or waste minimization/ decontamination technique can be completed.

The Tennessee Agreement in Principle, which is part of the Federal Facility Agreement, will set precedence for D&D of Building 9201-4 when it is signed. Since 9201-4 is contaminated with a hazardous waste and continues to release a once-released hazardous waste, RCRA may become the regulatory driver.

Efforts for remedial action for RMPE (ADS 210/G1 and G2) of upper EFPC (ADS 216/G3) at Y-12 continue within the ER Program. Unless the source of mercury is controlled or removed (~6 facilities) [define each?], downstream cleanup efforts will not reduce the risk.

3.2.1.1 Decontamination and Decommissioning of Building 9202

This project involves the D&D of ~7700 ft^2 within the High Head Area of 9202. The contamination levels in this area exceed federal and state Environmental Protection Agency (EPA) regulations and Occupational Health and Safety Act (OSHA) standards. This area is poorly utilized because it is equipped for outdated plant processes, lacks heat and air conditioning, and is in a state of ill repair. Environmental Monitoring studied this area and found high levels of cadmium, lead, PCBs, uranium, and mercury. Due to a need for space (as well as a basic need to clean up this area), funding for significantly greater decontamination activities than originally estimated are required before the already approved renovation activities can proceed. The driving force behind the decontamination is the opportunity to use this space for new laboratories for advanced processes. Continued expansion of the Development Division has put laboratory space at a premium. Deferral or delay of this activity will result in the continued unavailability of a prime laboratory area for the division. No releases have been identified to date.

The cost estimate is from a formal estimate from Engineering Transmittal S-01254, Fused Salt Laboratory/High Head Renovation. Costs do not include management of wastes.

A cost of ~$5.5M is projected for the decontamination of the High Head Area of 9202. The cost estimate has taken into consideration all the requirements from the Y-12 Health, Safety, and Environment (HS&E) Accountability Division, federal and state EPA requirements, and OSHA standards.

If not remediated, surrounding environments could be subject to contamination release from this source. The Y-12 Plant needs laboratory space, and as plans for modernization mature, the site of 9202 becomes of prime interest due to its strategic location near the plant laboratories and the Development Division.

Overall, these lithium and uranium projects are aimed at meeting the Plant Waste Minimization goals and at developing new technology for long-term plant modernization. Delays in the initiation of this remediation project will mean that the Y-12 Plant will continue to generate unacceptable waste levels for a longer time than necessary and that the modernization schedule will be held up.

3.2.1.2 Surveillance and Maintenance of Building 9201-4

Y-12 Metal Preparation **[organization correct?]** will provide S&M of Building 9201-4 until D&D is conducted. Maintenance will include routine housekeeping inspections and cleaning necessary to prevent deterioration. Preventive maintenance will include roof repairs, painting, and other general structural work to ensure integrity. Surveillance will include routine and periodic inspections of structural integrity as well as daily monitoring and assessment of the building to ensure containment of known contamination. Operational utilities will be part of every day maintenance. An average of 2000 lb/month of mercury is being recovered from process piping systems within the building as part of daily S&M.

A minimum level of S&M is presently being carried out to maintain compliance with all regulations and to ensure a minimum risk to the environment and to protect the employees' health and safety. This division's role will be to continue S&M activities until the building is no longer a threat to the environment and to workers.

Efforts are under way to produce an overall S&M plan for Y-12. Programmatic and organizational efforts are being initiated to prepare D&D plans in FY 1992. Routine S&M for 9201-4 is to be funded by GB funds until EW funding provides the appropriate level for this activity. Routine S&M will require $750,000 if all funding is to be generated from EW.

3.2.1.3 Surveillance and Maintenance

S&M of specified areas* of Buildings 9201-2, 9202, and other areas yet to be identified, will be provided until decontamination and demolition is conducted. Maintenance will include routine housekeeping inspections and cleaning necessary to prevent deterioration. Preventive maintenance will include such activities as ceiling and wall repairs, painting, and other general structural work to ensure integrity. Surveillance will include routine, periodic inspections of structural integrity, as well as periodic monitoring and assessment of contaminated areas and adjacent grounds to ensure containment of known contamination and identification of potential new contamination. Utilities will be kept operational, providing sufficient heat and

*Specified areas: 9201-2 basement, 9202 High Head Area (Fused Salt Lab); perimeter walls and drain lines.

light for continued maintenance. The intent of these routine S&M activities is to ensure that the environment and employee health and safety are protected and that contamination is contained within known boundaries.

It is unacceptable to allow facilities to deteriorate or go unattended, because such a situation would jeopardize the health and safety of workers and provide no control or containment of known contamination. Heating, ventilation, and air conditioning systems and utilities must be provided for workers' safety and convenience during maintenance operations.

3.2.2 Remedial Action

The 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA require that releases of hazardous wastes to all media (soil, surface water, groundwater, air) be evaluated to determine the extent and seriousness of contamination. This evaluation is conducted by completing a RCRA Facility Investigation (RFI). The investigation involves evaluating existing data, developing data quality objectives, and formulating a sampling plan for the affected media.

The RFI for the Group 4 Sites involves the collection of soil and water samples to determine the extent of releases of hazardous wastes at each site. The sites included are

- Upper EFPC
- Mercury Use Areas
- Abandoned Nitric Acid Pipeline
- SY-200 Yard

These sites have been combined into a single RFI to reduce the number of documents to be reviewed by the regulators and to improve execution of field sampling activities.

3.2.2.1 Reduction of Mercury in Plant Effluents

Text needed.

3.2.2.2 Mercury Use Areas Remediation

Upper EFPC is the main surface drainage channel leaving the Y-12 Plant. Virtually all discharge points in the main part of the plant discharge to upper EFPC. Organic compounds, PCBs, mercury, and other contaminants have been released into the creek during the operation of the plant.

The Mercury Use Areas is a collective term used to refer to areas where mercury was used or handled during the 1950s and 1960s. Mercury was used in the lithium isotope separation process in three buildings in the west end of the plant. The separation process was developed in the east end of the plant. There were also various buildings involved in the flasking and storage of mercury.

3.2.2.2.1 RMPE History of Activities

Elemental mercury was used at the Y-12 Plant from the mid 1950s to 1963 as part of the lithium isotope separation process. During the development and operation of the various exchange processes (organic exchange, electrical exchange, column exchange), a substantial amount of mercury was released to the environment. Estimated total releases follow:

Pathway	Amount (lb)
Air	51,000
EFPC	239,000
Ground surface at the Y-12 Plant	428,000
Loss to sediments in New Hope Pond	15,000
Total	733,000

In addition, 1,300,000 lb of mercury that is not accounted for represents the difference between the amount charged to the lithium isotope separation program and the amount accounted for as inventory and lost to the environment.

The RPME Program was established to address sources of mercury in the Y-12 Plant that are contributing to the mercury in plant effluent being discharged to EFPC. Initial efforts were begun in 1985 and consisted of water and sediment sampling of manholes and outfalls associated with the storm sewer system. Sampling activities were also conducted for groundwater collection sumps in the basement of various mercury-use buildings. This resulted in a storm sewer inspection, cleaning, and relining program to remove mercury-contaminated sediment from the storm sewers and to prevent infiltration of mercury-contaminated soils into the storm sewer system. A total of 8358 ft of storm sewer was cleaned and lined, and an additional 5588 ft of line was cleaned only. In addition, some noncontaminated sources of water were removed from the storm sewer system through the use of recirculation cooling loops.

Mercury-contaminated sediment and elemental mercury were removed from groundwater collection sumps in the basements of Buildings 9201-2, 9201-4, 9201-5, and 9204-4. Mercury-contaminated piping in the basement of these buildings was also identified for removal.

3.2.2.2.2 Operational Information

This section describes the operational history of each building or area included in the Mercury Use Areas and summarizes the available information on the nature and quantity of contaminants, chiefly mercury that was stored, spilled, or otherwise lost in each of the buildings and associated grounds.

Building 9733-1. Building 9733-1 was operated in 1951 and 1952 as a development facility for the Orex process. The Orex process was initially developed as a laboratory bench-scale; therefore, only beaker quantities of mercury, lithium, and ethylenediamine were used in the building. The organic solvent, ethylenediamine, was used to take the place of water in dissolving lithium. The building had a steel trap installed in the floor drain system to remove mercury from water flows before it entered the storm sewer. This trap was checked routinely for mercury and emptied. This system was incorporated on all future development and pilot facilities. In Building 9733-1, the trap is reported to have been effective in preventing metallic mercury from entering the creek (Wilcox 1983). Dismantling of this facility was undertaken in the late 1950s. No major losses of mercury were reported for this building, but mercury-contaminated soil was discovered outside the building in 1984. The building currently is used exclusively for offices.

Building 9733-2. Building 9733-2 was used in 1950 and 1951 as a development facility for the Elex process. Bench-scale laboratory experiments using the Elex process were set up in a few rooms of the building. Mercury was the only hazardous material used in the Elex process. Although the actual inventory of mercury used in this building is unknown, the quantity is thought to be small (<100 lb). With the abandonment of further development of Elex in favor of the Colex process, the facility was shut down and dismantled in the late 1950s. No major losses of mercury were reported for this building, but mercury-contaminated soil was discovered outside the building in 1984. The building currently is used exclusively for offices.

Building 9202. In addition to using Building 9733-1 for the Orex process, between April 1953 and May 1954, Building 9202 was operated as a development and pilot-plant facility for the Orex process. The building was stripped of process equipment in the late 1950s in conjunction with the dismantling of Buildings 9733-1 and 9733-2. Even now the building exterior walls and remaining drain lines are contaminated with mercury.

There were no reported spills associated with the pilot-scale Orex facility located in this building; however, an estimated 50,000 lb of mercury were lost at the building. Because the mercury was not recovered from the building trap, the trap and storm sewer were excavated in an effort to recover it. The excavated soil was later processed at Building 81-10.

Building 9202 currently houses the major development laboratories for the Y-12 Plant. Facilities include metallurgy, metallography, welding, wet and dry chemistry, corrosion testing, plating, ultraclean room, plastics and ceramics fabrication, chemical engineering, and electronics. The primary discharges from all laboratories are noncontact once-through equipment cooling water and heating and cooling condensate.

Building 9201-2. Building 9201-2 (Alpha 2) was used in 1950 and 1951 as a process development facility for the Elex process. The building was subsequently used from September 1952 through 1955 as a major Colex development facility, and several Colex pilot plants were built and operated during this time period. Upon shutdown of the Colex test facilities, mercury was transferred to other isotope-separation facilities. The first floor of the building was subsequently converted to office space.

During operations in this building, the mercury inventory was 321,753 lb, of which 186,596 lb was transferred to other facilities when the test facilities were closed, leaving 135,157 lb unaccounted for. Subsequent to closure, small amounts of mercury were recovered. For example, on June 7, 1983, 800 lb of mercury was recovered from an unused pipe in the building. Mercury is known to still exist in the building structure. When several walls were removed on the first floor to convert it to office space, mercury seeped out of the walls. Very small beads of mercury were still visible in the basement in 1983. On three occasions mercury was spilled in the building and seeped through the floor into the dirt basement. Extensive efforts were made to recover the mercury but without much success. A heavy layer of sulfur was finally added to the top of the dirt basement floor to contain any mercury vapor.

This building houses the ORNL Fusion Energy Division, with sections also occupied by the ORNL Engineering Technology and the Isotopes Division. The Fusion Energy Division is involved in research that leads toward the goal of controlling and using energy from thermonuclear fusion. The use of chemicals is small in this building and is mainly limited to laser dyes and to electroplating operations.

Building 9204-4. A production-scale plant using the Elex process was operated in Building 9204-4 (Beta-4) between August 1953 and March 1956, at which time the facility was put into standby status. All process equipment was opened and cleaned, with mercury being transferred to the Colex production plants in Buildings 9201-5 and 9201-4. In late 1956, Beta-4 was stripped of process equipment to make the space available for other purposes. The job of dismantling and removing the process equipment was contracted to the H. K. Ferguson Construction Company and was completed by December 1956.

No spills have been reported for this building, although they almost certainly occurred and would have been difficult to contain within the building because it lacked the control structures installed in the other large production buildings (9201-4 and 9201-5).

Building 9204-4 currently houses major production facilities involved with forging and forming depleted uranium, heat treatment of forged and formed parts, disassembly of retired weapon assemblies, and machining operations.

Building 9720-26. Building 9720-26 was constructed in the early 1960s specifically for the storage of surplus flasks of mercury. Today the building is still used for storage of mercury. Flasks are stored on pallets of 45 flasks per pallet, and the pallets are stacked three high. As of 1983, the inventory of mercury stored for the General Services Administration in this warehouse consisted of 6,404,900 lb in a total of 84,275 flasks (Wilcox 1983). No spills have been recorded for this building.

Deflasking Area (near Building 9103). For the receipt and transfer of mercury to Colex-process buildings 9201-4 and 9201-5, a special mercury unloading facility at the present site of Building 9103 was constructed and used by the Rust Engineering Company. The facility consisted of an open structure having three unloading docks. Large fans were used to ensure adequate air flow during deflasking operations. At the facility, mercury flasks were unloaded from trucks at the docks, gravity fed to an emptying area, opened using impact wrenches, and emptied into a trough where the mercury was then collected in a three-section storage tank. The plant grid coordinates of the tank (N30847, E55764 for the northwest corner) obtained from a 1954 drawing (Rust 6888-P29, October 12, 1954) indicate that the deflasking area is now essentially covered by Building 9103. Some spillage of mercury certainly occurred here when the deflasking operation was under way, but no estimates are available.

Building 9103 was constructed to house offices and computer facilities and is presently being used for this.

Flask Storage Area Near Guard Portal 33. An area west of Building 9204-4 near Guard Portal 33 was used as a storage area for emptied mercury flasks. Empty flasks brought from the Rust deflasking area near Building 9103 were transferred to this area, where Rust employees attempted to drain and collect any remaining mercury from the flasks. The flasks were held in the storage yard for salvage or eventual reuse. This area undoubtedly received many small mercury spills. Subsequently, the area was used for storage of contaminated scrap metal and other materials.

Building 9720-24. Building 9720-24, located immediately west of Building 9204-4, has been listed previously as having mercury contamination. However, in the CERCLA Preliminary Assessment report prepared by H&R Technical Associates, Inc. (Allison 1988), the authors were unable to verify that such contamination existed. The building is currently used for dye storage.

3.2.3 Sampling Plan—Mercury Use Areas

Author of this section: Please add callouts to Figs. 3.6 and 3.7 and Tables 3.3 and 3.4 to this section of text or add text to support callouts.

3.2.3.1 Surface Water

Objectives of the surface water sampling program are to evaluate contaminant movement via the surface water pathway and to quantify the volumetric flow. The surface water pathway is judged to be the most significant route by which mercury and other contaminants released from the Mercury Use Areas may reach human populations. The relative contributions of the various buildings and facilities to the mercury and other contaminant loading of upper EFPC have not been evaluated in detail since completion of the Reduction of Mercury in Plant Effluents Project (1988). Thus, the RCRA Facility Investigation can also serve to evaluate the effectiveness of an earlier corrective measure. However, the main thrust of the surface water plan will be to identify specific sources of mercury and other contaminants, that is, to trace elevated mercury concentrations to their source.

3.2.3.2 Technical Approach

A phased sampling approach will be employed to characterize the nature and extent of hydrologically dependent contaminant transport. This approach will enable modifications to the sampling program (e.g., addition or relocation of monitoring station locations) during subsequent sampling efforts, if previous data indicate such a need. In addition, surface water samples specified in this subsection will be collected in conjunction with surface water samples collected as part of the upper EFPC investigation.

Many pipes of varying diameters that originate or pass through the Mercury Use Areas discharge water into upper EFPC. Previous experience with pipe sampling at the Y-12 Plant has shown that not all pipes can be accessed for sampling and that only a few can be sampled on any given day. In Phase 1 of the surface water sampling plan, each pipe that originates or passes through a Mercury Use Area will be sampled (grab-type) at the point of discharge into upper EFPC on at least four occasions representing dry weather flow (no rainfall prior 3 days) and on four occasions representing wet weather flow (significant runoff-producing rainfall in the previous 24 h). Instantaneous discharge will be measured simultaneously. As this activity is expected to overlap with the remedial feasibility investigation to be conducted for upper EFPC, the timing of sampling will be closely coordinated whenever possible to minimize duplication of effort.

Phase 2 sampling will consist of progressive upstream sampling of each major trunkline that exhibited significant mercury loading (>1 g/d) in Phase 1. At each accessible confluence with tributary pipes, each tributary pipe will be sampled and its flow measured under dry-weather flow conditions. Relatively stable flow conditions are necessary for this kind of source tracing to be effective and thus no wet-weather sampling is planned for Phase 2. This sampling scheme will be repeated at approximately 1- to 2-week intervals for each trunkline four times. More frequent sampling cannot be conducted because of practical limitations on the number (maximum of 10 to 15 per sampling team) of storm sewers that can be entered within a workday.

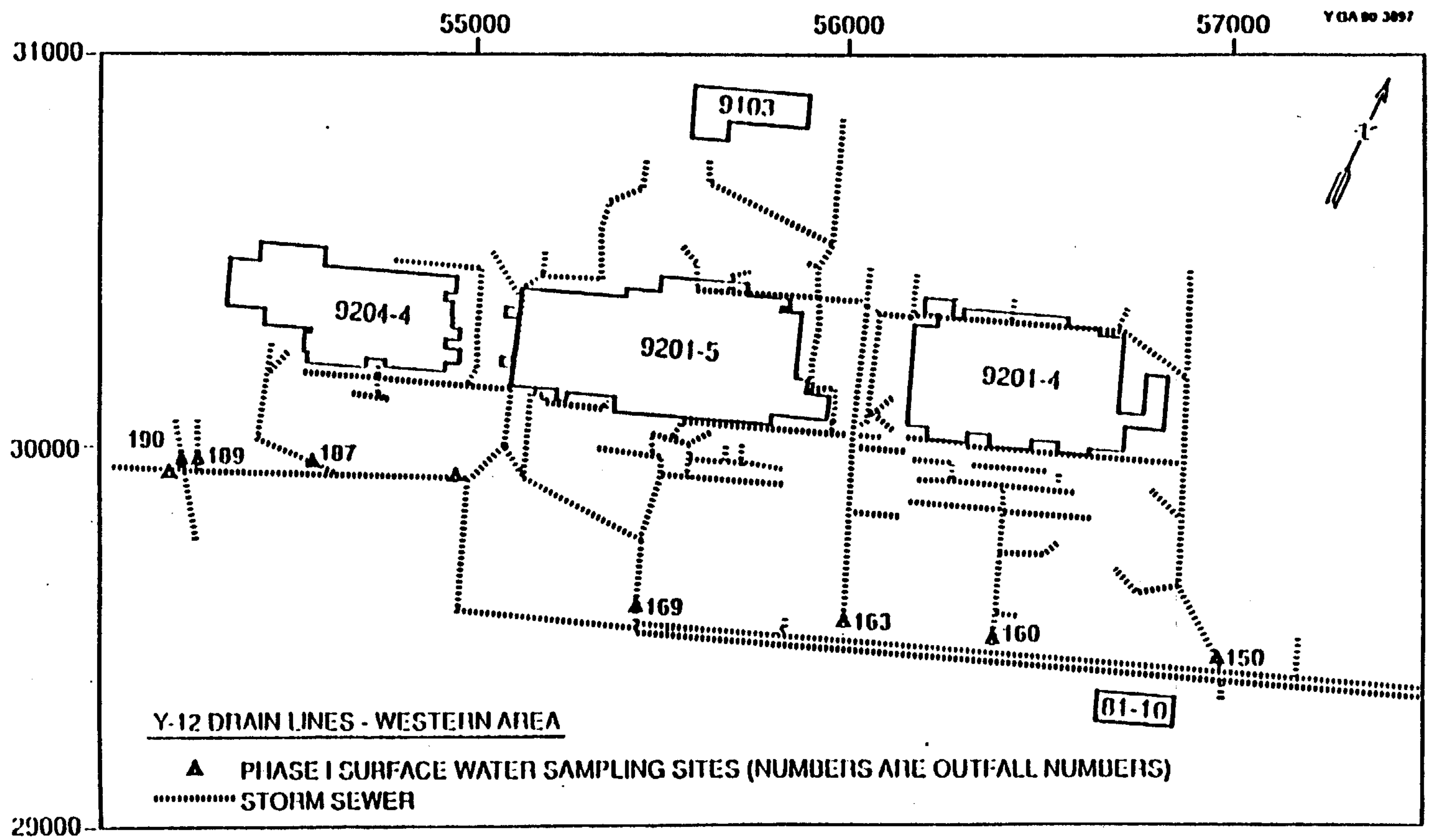

Fig. 3.6. Proposed Phase I surface water sampling sites (western area).

Table 3.3. Characteristics of trunkline sampling sites

Outfall number	Diameter (in.)	Type*	Flow (gpm)	Area/building served	Outfall category	UEFPC RFI site
47	24	RCP	140	9202		No
48	24	RCP	50	9202, 9201-2		No
49	15	VC	100	9201-2		No
51	15	RCP	40	9201-2		No
52	10	ST	0	9201-2		Yes
55	14	CI	100	9201-2		No
63	12	TC	5	9201-2		No
64	12	RCP	0	9201-2		Yes
109	48	RCP	334	9733-1/2		No
113	18	RCP	20	9733-1/2		No
150	48	RCP	458	E9201-4	III	No
160	36	RCP	100	C9201-4	III	No
163	36	RCP	50	W9201-4		No
169	48	RCP	207	SE9720-5	III	Yes
	72	RCP	?	SE9720-5		No
	72	RCP	?	NW9720-5		No
187	36	RCP	15	W9204-4		Yes
189	60	RCP	100	W-204-4		Yes
190	36	RCP	0	W9204-4		Yes
	36	RCP	?	NE9720-33		No

*CI = cast iron pipe
RCP = reinforced concrete pipe
ST = steel pipe
TC = terra-cotta tile
VC = vitrified clay pipe
UEFPC = upper East Fork Poplar Creek
RFI = Resource Conservation and Recovery Act Facility Investigation

Table 3.4. Plant grid coordinates of the proposed soil sampling sites

Site	Northing	Easting	Hg (μg/g)
1	29578	51433	102
2	30250	53650	103
3	30140	54391	106
4	29390	57815	113
5	29470	56605	116
6	30580	53203	119
7	29250	58450	124
8	29040	63430	126
9	28880	63320	127
10	29500	54100	127
11	30350	56150	129
12	29915	52100	141
13	29160	61985	142
14	28900	60736	143
15	29720	51600	163
16	29050	63440	167
17	28750	61230	173
18	28930	63340	185
19	29260	58350	219
20	29550	51550	237
21	30245	53785	243
22	28700	61350	254
23	29560	51527	257
24	30303	56197	259
25	29350	56950	260
26	29600	52740	290
27	29950	56150	317
28	29670	60960	240
29	30260	53852	347
30	30050	55695	391
31	29570	63600	424
32	30650	53460	777
33	29333	57633	1700
34	30250	54530	1900
35	30348	53818	7700

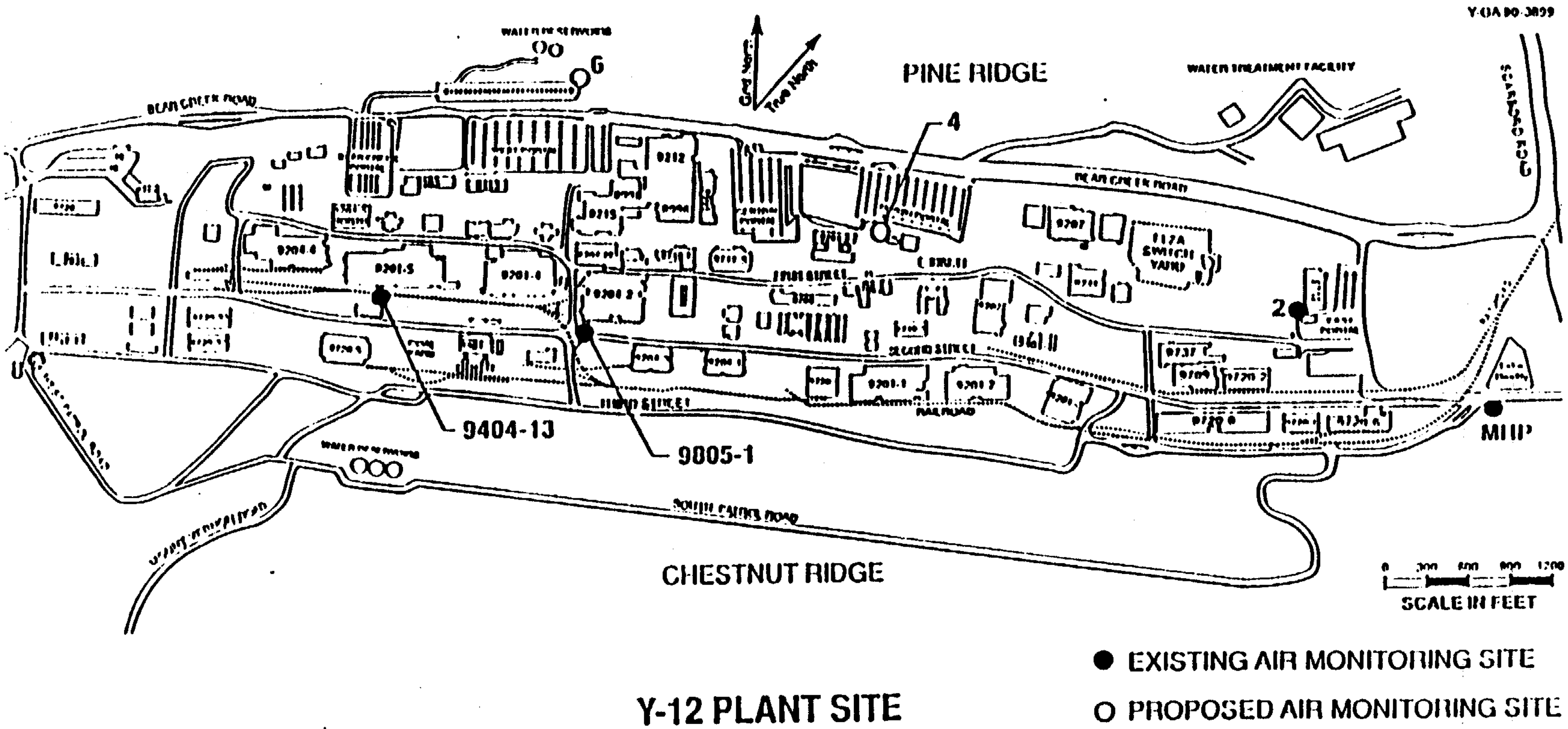

Fig. 3.7. Existing and proposed locations for the monitoring of mercury in ambient air.

3.3 OAK RIDGE K-25 SITE

3.3.1 Decontamination and Decommissioning

Text needed.

3.3.2 K-1420 Mercury Recovery Room

The K-1420 Mercury Recovery Room is in Building K-1420, which is located on the northeast side of the K-25 Site (formerly known as the Oak Ridge Gaseous Diffusion Plant) within the security fence. During the 1960s and 1970s, operations in the K-1420 Mercury Recovery Room included cleaning used mercury and recovering mercury from mercury-bearing wastes with a distillation process. A change in the allowable concentration limits for airborne mercury under the National Emission Standards for Hazardous Air Pollutants required upgrading the K-1420 Mercury Recovery Room's ventilation system. K-25 Site management decided not to renovate the exhaust system, and the mercury recovery operation was shut down in the early 1980s. Presently, the room contains the ventilation hoods, distillation equipment, and other equipment associated with the recovery process. Mercury-bearing wastes and used mercury are sent to the mercury recovery room to be packaged in appropriate containers.

Since mercury recovery was the principal objective, measures were taken to prevent spills. Mercury-contaminated wastes and used mercury were washed with nitric acid in a 2.5- to 5-gal container in a sink. The sink contained a standpipe, which prevented materials from entering the drain at the sink level. Washed solutions were transferred to the distillation units. Spills associated with the distillation units were contained in a curbed area beneath these stills. A floor drain in the center of the mercury recovery room was raised from the floor level, preventing most spills from entering the drain line. However, mercury was found in the center floor drain when the line was accidentally punctured. To immobilize the mercury, the line was grouted and capped where the line exits from Building K-1420, and the floor drain in the mercury recovery room was sealed.

The operational history of the K-1420 Mercury Recovery Room suggests that atmospheric transport is the primary pathway of concern. Drain lines that exit the mercury recovery room present some potential for contaminant release to the soil and groundwater beneath the building. Contaminant release to the soil and groundwater beneath the building would come from leakage of the drain lines that exit the room or from contaminant movement through the concrete flooring. Operational protocol would have prevented accumulation of mercury on the floor; therefore, the loss of large amounts of mercury through penetration of the floor is unlikely. If analyses of floor paint chips and associated air samples indicate unacceptable contaminant levels, soil and groundwater sampling will be performed. Contamination of surface water or vegetation is unlikely because of the location of the mercury recovery room, and surface water and vegetation will not be evaluated as pathways of contaminant migration. As previously stated, because of the volatility of elemental mercury, atmospheric transport is the pathway of greatest concern in the mercury recovery room. Samples of air will be taken from the mercury recovery room, ventilation ducts, and the ventilation exhausts as part of each sampling phase to determine the nature and extent of contamination.

3.4 OAK RIDGE NATIONAL LABORATORY

3.4.1 Decontamination and Decommissioning

ORNL has served as a multipurpose energy research facility with a major emphasis on nuclear energy. This mission has resulted in a significant inventory of research, development, and small-scale isotope production facilities with varying amounts and types of radionuclide contamination. However, mercury contamination, where it may exist, is expected to be a minor consideration in the overall scope of hazardous material cleanup that will ultimately be considered in facility decommissioning. None of the facilities currently supported by the DOE D&D Program have known mercury contamination problems. However, a few active facilities at ORNL have used mercury as part of their past R&D or production activities, and residual quantities may still exist within the facilities. These active buildings include 3503, 3592, 4501, 4508, and 9201-2, an ORNL facility at Y12. Descriptions of past activities conducted in buildings 3503, 3592, and 4501 are included in Sect. 3.4.2. A description of activities conducted in Building 9201-2 is found in Sect. 3.2.3.3. As these facilities are shut down and accepted by the D&D Program, plans for interim management and ultimate removal of the residual mercury inventories will be developed. At the present time, there are no schedules for the decommissioning of these active facilities.

3.4.2 Remedial Action

Background. Several sites in WAG 1 at ORNL, described below, are contaminated with mercury.

1. Building 4508. Research activities in Building 4508 have used mercury, and there is apparently soil contaminated with mercury outside of the building possibly caused by spills. There are no soil sampling data.

2. Building 4501. The building was used from April to November 1954 as a small pilot plant supporting the lithium separation process (Orex). Tons of mercury were used, and spills occurred. The visible mercury was cleaned up, but mercury escaped through cracks in the concrete floor. Soil analyses around the building from 1983 show mercury concentrations ranging from 0.05 to 465 ppm.

3. Building 3592. The building was used in 1956 for equipment development work supporting the research in Building 4501 on lithium separation. Over 60,000 lb of mercury was used, and operating personnel estimate that ~2000 to 3000 lb was spilled and leaked. Soil analyses around the building from 1983 show mercury concentrations ranging from 4.1 to 320 ppm.

4. Building 3503. During the 1950s and early 1960s substantial quantities of mercury were used in this building in the spent fuel reprocessing program known as Purex. No information exists on quantities of mercury lost, but some soil samples from around the building show concentrations ranging from 0.8 to 24 ppm.

5. Sediments. Mercury-contaminated sediments exist in all of the ORNL WAG 1 drainages. The areas of greatest concern are located below the NPDES discharge points 309 and 261 in White Oak Creek and Fifth Creek, respectively. While the contaminated areas appear to be limited in horizontal and vertical extent, concentrations of ~5000 mg/g exist.

Remediation Plan. Based on receipt of Case 1 funding levels, the plan for remediation is as follows:

- FY 1993: Identify all locations of contamination and evaluate sources.
- FY 1994: Prepare interim ROD and initiate remedial design.
- FY 1995: Complete remedial design and project plans and initiate remedial action.
- FY 1996: Complete remedial action.
- FY 1997: Initiate ongoing performance assessment monitoring.

3.5 OTHER TECHNICAL SUPPORT

3.5.1 Biomonitoring

3.5.1.1 Historical Background

Y-12. On May 24, 1985, an NPDES permit was issued for the Oak Ridge Y-12 Plant. A special condition of the permit required implementation of a biological monitoring program (Loar et al. 1989) for EFPC.

BMAP was developed to meet two major objectives. First, studies were designed to provide sufficient data to demonstrate that the effluent limitations established for Y-12 protect and maintain the classified use of EFPC. The two most significant uses of EFPC are (1) growth and propagation of fish and aquatic life and (2) recreation, including fishing and swimming.

The second major objective of the Y-12 BMAP is to document the effects on stream biota resulting from implementation of a water pollution control program at Y-12. This program consists of strategies to (1) eliminate direct discharges of wastewaters to EFPC and (2) minimize inadvertent release of pollutants to the environment.

ORNL. On April 1, 1986, an NPDES permit was issued for ORNL. A BMAP (Loar et al. 1986a) was also required as a special condition of this permit.

The ORNL BMAP has three major objectives. The first two objectives are similar to those for Y-12: (1) demonstrate that effluent limitations established for ORNL protect and maintain the classified uses of White Oak Creek and Melton Branch and (2) document the effects on stream biota resulting from implementation of a water pollution control program at ORNL. For White Oak Creek and Melton Branch, the classified uses include growth and propagation of fish and aquatic life and livestock wildlife and watering.

The third major objective of the ORNL BMAP is to provide an ecological characterization of White Oak Creek and tributaries that can be used to (1) document ecological impacts of past and current operations, (2) identify contaminant sources that adversely affect stream biota, and (3) provide baseline data that can be used to determine the effectiveness of remedial actions.

K-25. On September 11, 1986, a modified NPDES permit was issued for the Oak Ridge Gaseous Diffusion Plant (now known as the Oak Ridge K-25 Site). The modification to the permit specified that a BMAP (Loar et al. 1986b) be implemented for Mitchell Branch, a tributary of Poplar Creek (also known as the K-1700 stream).

Objectives of the K-25 BMAP are similar to those of the Y-12 BMAP: (1) demonstrate that effluent limitations established for K-25 protect and maintain the classified use of Mitchell Branch and (2) document the effects on stream biota resulting from operation of the Central Neutralization Facility and the Toxic Substances Control Act (TSCA) Incinerator. In the case of Mitchell Branch, the only classified use is growth and propagation of fish and aquatic life.

3.5.1.2 Current Plans

Y-12. Because of the complex nature of the effluent discharged to EFPC and the temporal and spatial variability in the composition of the effluent, a multitiered, integrated approach to biological monitoring has been developed as the basis of the Y-12 BMAP. The program consists of four tasks: toxicity monitoring, bioaccumulation studies, biological indicator studies, and instream monitoring. These tasks combine well-established monitoring methods with more innovative state-of-the-art techniques to establish regulatory compliance.

Toxicity testing is conducted on water from EFPC, selected point sources, and reference streams. The bioaccumulation task (1) identifies materials that accumulate in biota of EFPC and documents changes in the accumulation of contaminants in biota following implementation of waste treatment measures, (2) quantifies dynamics of bioaccumulation of contaminants with particular emphasis on the sources and bioavailability, and (3) is developing a predictive capability for estimating the integrated body burden of EFPC biota based on laboratory experiments and field studies. Biological indicators can be defined as selected components or variables of organisms, populations, or communities that respond in a variety of biologically meaningful ways to changes in the environment. At Y-12, biological indicators are used to evaluate the responses of fish populations and communities in EFPC to the plant effluents and the changes in effluent chemistry over time. In-stream monitoring involves field sampling of the benthic invertebrate and fish populations in EFPC to (1) characterize spatial and temporal patterns in the distribution and abundance of these populations downstream of Lake Reality and (2) document the effects of new wastewater treatment facilities on community structure and functions.

ORNL. With relatively minor differences related to specifics of White Oak Creek and contaminants from ORNL, the four tasks of the Y-12 BMAP are also included in the ORNL BMAP. However, the ORNL BMAP also includes two additional tasks: assessment of contaminants in the terrestrial environment and radioecology of White Oak Lake and White Oak Creek.

The objectives of the biological monitoring program for terrestrial biota are (1) to document the contaminants that are present in elevated amounts in the terrestrial environment, (2) to examine the potential for mobility and availability of these contaminants to terrestrial biota, and (3) to select the appropriate species and protocols for more detailed biological monitoring, as needed.

White Oak Lake, which was impounded in 1943, serves as the final settling basin for radioactive effluents from ORNL before they are released over White Oak Dam. Understanding the transport of radionuclides between the various ecological and abiotic components of White Oak Lake is essential to understanding the fate of radionuclides released into the White Oak Creek system.

K-25. Effluent discharges to Mitchell Branch are complex, consisting of trace elements, organic chemicals, and radionuclides in addition to various conventional pollutants. Moreover, the composition of these effluent streams will be changing over time as various pollutant abatement measures are implemented. Although contaminant input to the stream originates primarily as point sources from existing plant operations, area sources such as the classified burial grounds and the K-1407-C holding pond cannot be eliminated as potential sources of contaminants.

Because of this spatial, chemical, and temporal complexity, the K-25 BMAP incorporates the same multitiered, integrated approach as the Y-12 BMAP. Toxicity monitoring, bioaccumulation studies, biological indicators, and in-stream monitoring are the major components of the K-25 BMAP.

3.5.1.3 Documentation of Mercury Contamination

Since 1985, mercury contamination in sunfish has been monitored twice yearly at five sites in EFPC, from the outfall of New Hope Pond/Lake Reality at the Y-12 Plant to the lower reaches of the creek. Mercury contamination remains highest at the site nearest Y-12 and decreases with distance downstream. BMAP monitoring has also documented mercury contamination in fish in White Oak Creek, Bear Creek, Mitchell Branch, and lower Poplar Creek. The Y-12/EFPC source, rather than the K-25 source, could account for the observed contamination in lower Poplar Creek and Mitchell Branch. A separate sediment contamination study (Ashwood et al. 1986) demonstrated that mercury levels were elevated above background in Poplar Creek at the mouth of EFPC, in EFPC, and in Bear Creek near the confluence with EFPC. Mercury contamination in fish in Bear Creek and White Oak

Creek undoubtedly arises from distinct sources in those drainages. Monitoring of mercury contamination in fish in these systems continues on at least an annual frequency. BMAP monitoring and, more recently, the Clinch River RCRA Facility Investigation effort have documented that mercury contamination in fish is at background levels in the Clinch River below White Oak Creek; however, low—but above background—concentrations of mercury occur in Clinch River fish below the mouth of Poplar Creek.

Experimental exposures of fish to the Y-12 discharge or highly contaminated EFPC/New Hope Pond sediments indicated that the ongoing discharge of mercury to upper EFPC is much more significant in sustaining the levels of mercury contamination in fish than the reservoir of mercury in stream sediments. Experimental exposures planned for 1991 will help determine the degree to which Mitchell Branch and upper Bear Creek are sources of mercury contamination.

4. TECHNOLOGY DEVELOPMENT

4.1 INTRODUCTION

Industrial mercury contamination presents special problems in characterization, water treatment, soil treatment, source control, decontamination, and decommissioning for which there are currently few, if any, proven solutions. Thus, research and technology development are needed in several areas of mercury remediation at the Oak Ridge facilities. Most of these needs are not currently being addressed by specific DOE-supported activities (ADSs). The special problems stem both from the complex environmental chemistry of this metal and from the fact that unacceptable human health and ecological risks occur at very low concentrations of mercury in environmental media.

4.1.1 Characterization

Characterization of the concentrations of total mercury and mercury forms (speciation) in environmental samples is essential for risk assessment and to the task of identifying appropriate corrective measures. The analysis of mercury in environmental media, especially soil and sediment, is presently restricted to laboratory protocols. No analytical protocols suitable for application in a field situation are available, although several possibilities exist. Field analysis of mercury vapor in air and soil gases can be an effective exploration tool in mineral prospecting, but this approach to field mapping will fail if mercury occurs in soil in forms other than elemental mercury (e.g., mercuric sulfide). Rapid, at least semiquantitative, analytical methods are needed to facilitate (1) rapid mapping of soil contamination along the floodplain of EFPC and (2) field verification of cleanup efficacy. Laboratory protocols are time consuming and thus costly and not conducive to timely decision making during mapping and cleanup.

The contractor (SAIC) performing the RCRA Facility Investigation for EFPC requested the assistance of the Analytical Chemistry Division at ORNL in identifying and testing several candidate approaches to rapid laboratory or field screening for mercury in soils. The chief protocol considered was X-ray fluorescence spectrometry, either employing a portable unit or a laboratory trailer-deployed unit. The technique proved unworkable in the field due to interference from soil moisture. Ultimately, a laboratory protocol (involving neutron activation) with a 4- to 5-day turnaround was chosen. The technique will give acceptable screening results for soils with more than about 20 μg of mercury per gram of soil.

Other candidate field screening techniques include thermal release of mercury from the soils and trapping the gaseous mercury on gold absorbers with rapid field analysis using a portable mercury vapor analyzer, such as the Jerome Model 411. At least one company in the private sector appears to be pursuing further development of this technique.

Efforts to develop analytical techniques to determine chemical species of mercury in environmental media has experienced much success in the past few years. These techniques have been, or are now being, applied to the characterization of mercury forms in water, sediment, soil, and biota from the Oak Ridge contaminated sites. For example, Revis et al. (1989) reported that 85% of the mercury in the floodplain of EFPC occurred as the insoluble mercuric sulfide.

4.1.2 Water Treatment

Although mercury has been successfully removed from a variety of wastewaters by a large range of treatment techniques, most of these techniques are not very effective in reducing mercury concentrations to environmentally acceptable levels (e.g., to subparts per billion). The available methods are suitable only for the scenario where an industrial plant is discharging a small volume of treated effluent into a large receiving stream or other water body. The Y-12 Plant sits astride the headwaters of EFPC and thus essentially no flow is available for dilution of treated effluents. Water in the headwaters of EFPC currently averages about 2 μg/L in mercury concentration. Individual effluents that enter the headwaters range up to about 100 μg/L. It may be anticipated that some of these effluents will have to undergo treatment if a significant reduction in mercury concentration in the headwaters is to be achieved.

One contract to explore innovative water treatment for mercury has been awarded by the Office of Technology Development of DOE (through Argonne National Laboratory) to a private company in New Mexico (Bio-Recovery Systems, Inc.). This contract is managed by SAIC (Oak Ridge). The technique employs an natural ion exchange medium called "AlgaSORB" which can, according the vendor, reduce mercury in water to nondetectable levels. However, the contract states that "drinking water standards" will be used as the effluent target for the process. In FY 1991 the company was shipped specimen effluents to test their treatment process. The project began October 1, 1990, and will be completed July 31, 1991. The project budget is $288,500. Details of milestones were unavailable.

The DOE Office of Technology Development (OTD) has also supported through ADS OR-368-AK an informal joint effort among ORNL, the EPA, and the Electric Power Research Institute (EPRI) directed at stimulating the genetic potential of naturally occurring, mercury-resistant bacterial populations endemic to EFPC to manage the chemical speciation of mercury in the creek. The goal is to avoid the in-stream production of methylmercury, the chemical form which is most toxic and which accumulates in aquatic biota. Although this effort has been focused on direct application to the creek, it would be equally applicable in a wastewater treatment scenario wherein naturally occurring bacteria are stimulated to eliminate mercury from wastewater by reducing the mercury to the elemental form which may be volatilized and trapped on medium such as iodated, activated charcoal. Although DOE has not provided FY 1991 funding for this project, which began in February 1989, minor elements of the work have been sustained by supplemental funding from the Y-12 Plant and DOE-OR. Both EPA and EPRI maintain a keen interest in using the Oak Ridge site to explore this innovative approach and have retained some activity in Oak Ridge even in the absence of significant participation by DOE.

The original schedule for ADS OR-368-AK showed three tasks: (1) site characterization (completed in 1990), (2) microcosm studies to identify means to stimulate the desired microbial activities (to be completed in 1991), and (3) pilot-scale field demonstration (to be completed in 1992). Tasks 2 and 3 may not be completed because no FY 1991 funds have been received, and the project has been targeted for premature termination. Recently, an EPRI-supported group of researchers at the University of California-Irvine seeded a bioreactor containing mercury-contaminated sediment from the Oak Ridge creek with a mercury-resistant bacterial culture and demonstrated amplification of the activity of the genes that control mercury detoxification. The EPA is supporting a similar effort at Utah State

University directed at developing a wastewater treatment technology based on the use of mercury-resistant bacteria. ORNL staff members have been participating informally in these efforts. It seems likely that EPRI and EPA will continue to support development in this area, although no direct support to Oak Ridge from these entities is anticipated. Approximately $90,000 was received from OTD in FY 1989 and $140,000 in FY 1990. Approximately $20,000 in FY 1990 carry-over funds is still available but committed to an Interagency Agreement with EPA for FY 1991. The EPA effort in FY 1991 will include microcosm studies and is only partially covered by the $20,000 from OTD.

4.1.3 Soil Treatment

Treatment of mercury-contaminated soil, either in situ or after excavation, is one of the most critical problems facing the remediation of mercury at the Oak Ridge facilities. Many millions of cubic feet of soil are contaminated with mercury, some at levels approaching and exceeding percentage concentrations. Human health and ecological risks will likely eliminate the need to consider treatment for the bulk of these soils, which are expected to pose negligible risk if left in place or simply capped to prevent circulation in the biosphere. Some soils will almost certainly have to be excavated or treated in situ to recover mercury and possibly other contaminants.

The only soil treatments known to have been evaluated thus far include (1) thermal and (2) electrokinetic treatments. Thermal treatment research has involved only pilot-scale incineration of soil specimens from the contaminated floodplain along EFPC. Browning Ferris Industries (BFI) performed these tests in FY 1990 for the ER Division (personal communication, Frank Van Ryn, Hazardous Wastes Remedial Actions Program). The electrokinetic treatment studies are carried out by a private company (Electro-Petroleum, Inc.) through a contract from OTD. Argonne National Laboratory solicited the proposals for this work and manages the contract for DOE.

Both thermal and electrokinetic soil treatment methods have major obstacles to overcome. Thermal treatment of soil can generate quantities of liquid and solid waste equivalent to the quantity of treated soil. In addition, in situ treatment may not be practical, and excavation may be necessary prior to treatment. Electrokinetic treatment requires conversion of inorganic contaminants, such as mercury, into ionic forms which can migrate in the imposed electric field. Pretreatments to convert the inorganic contaminants to ionic forms are harsh and create additional hazards. Lastly, there is considerable uncertainty regarding the rates of migration of metallic ions in a soil matrix even under a strong imposed potential gradient. Limited research carried out at the Westinghouse Savannah River Plant has suggested that mercury can be migrated in soils to a useful extent (Jane Bibler, personal communication). **[Note: please provide a more complete reference, preferably something with hard copy that can be cleared for public release.]**

The contract with Electro-Petroleum, Inc., started on October 1, 1990, and runs through March 31, 1992. The budget is $278,952. No schedule or budget information is available for the BFI project. Results of the BFI effort have, however, been relayed to ER staff.

4.1.4 Source Control

Source control for mercury contamination can be simple or complex depending on the nature of the contamination. Control measures include source excavation, isolation, and stabilization. The mechanism of release of mercury from certain facilities in the mercury-use areas at the Y-12 Plant provides a significant challenge for control. Specifically, it has been hypothesized that spilled elemental mercury has migrated into the porous gravel fill beneath building foundations and maintains saturated concentrations (20 to 60 μg/L) in the slowly moving groundwater which occupies this fill. The groundwater is drawn toward the building sumps by pumping and is discharged into the extensive storm drain system. High clay content and very low hydraulic conductivity of the surrounding soils and other geologic media preclude significant migration of the solubilized mercury except through the gravel fill, and thus groundwater monitoring wells installed adjacent to the buildings rarely show significant mercury contamination. Excavation of the mercury in the gravel fill is impractical without demolishing buildings. Therefore, techniques are needed either to provide an alternate pathway for clean groundwater (e.g., by artificially depressing the water table in the vicinity of buildings) or to isolate or stabilize the mercury to prevent further dissolution. The main alternative to these approaches is to capture and treat the contaminated groundwater prior to discharge to surface water.

No effort is currently under way to evaluate source control for the building foundations. Studies were planned as part of the RMPE but have not been started due to funding delays. The minimum effort would entail simply reducing the sump discharges to the lowest levels and then providing treatment for this discharge. Some sump discharges have already been reduced by rerouting controllable water flows away from the sumps. Means to physically or chemically stabilize mercury in the gravel fill, while maintaining the ability to dewater the building foundations, are not currently available. Injection of absorbent material into the gravel represents one option that should be explored. Complete grouting of the fill material represents another option, although whether this option could be tolerated is unknown.

4.1.5 Decontamination

Decontamination of mercury-contaminated materials, including especially process equipment, building materials, and plumbing, is a necessary component of the decommissioning of Mercury-Use Area facilities. While some technology is already available, more is needed to deal with the variety of materials which require decontamination. For example, many tons of mercury-contaminated metal exist which must either be decontaminated for recycling or disposing of as a RCRA hazardous waste (Category D009). Much of this metal scrap includes valves and other items which may contain occluded mercury contamination.

OTD is addressing the issue through ADS OR-374-AC, "Toxic Metals from Contaminated Scrap." Although this effort is currently on hold pending FY 1991 funding, the intent of the effort was to fund the private sector to perform demonstrations of innovative techniques, including, for example, solid CO_2 blasting. The proposed schedule and budget can be obtained from the project investigator (S. P. N. Singh, 574-6639).

4.1.6 Decommissioning

Decommissioning of mercury-use area facilities will require a variety of special handling procedures due to the toxicity and volatility of mercury. Traditional methods of cutting up process equipment for salvage invariably involve high temperatures because of the use of cutting torches and metal-cutting saws. These methods are unacceptable for mercury-contaminated equipment due to the release of mercury vapor into the air near the cutting operation. Thus, alternate methods of cutting are required. Although metal shears may be suitable for thinner metals, shearing will be inadequate for much of the equipment.

The only known technology development project related to decommissioning of the Mercury-Use Area Facilities is one project directed at using ultra-high-pressure abrasive/water jet to cut metal.

4.2 FUTURE TECHNOLOGIES AND DEVELOPMENT PLANS

Text needed.

4.3 RECOMMENDATIONS

Text needed.

5. FUTURE PLANS AND IMPLEMENTATION

Text needed.

5.1 FINDINGS

5.2 RECOMMENDATIONS

REFERENCES

Ashwood, T.L., et al. 1986. Sediment Contamination in Streams Surrounding the Oak Ridge Gaseous Diffusion Plant, ORNL/TM-9791.

Jane Bibler, personal communication.

Loar, J.M., et al. 1986a. Biological Monitoring Plan and Abatement Program for White Oak Creek Watershed and the Clinch River. DRAFT ORNL/TM.

Loar, J.M. et al. 1986b. Biological Monitoring and Abatement Program for Mitchell Branch. DRAFT ORNL/TM.

Loar, J.M. et al. 1989. The Oak Ridge Y-12 Plant Biological Monitoring and Abatement Program for EFPC. ORNL/TM-10265.

Revis et al. 1989. *Distribution of mercury species in soil from a mercury-contaminated site,* Water, Air, and Soil Pollution 45: 105-113, 1989.

Travis, C.C., et al. 1989. Final Report of the Oak Ridge Task Force Concerning Public Health Impacts of the Off-Site Contamination in EFPC and Other Area Streams, ORNL/TM-11252.

Authors: please prepare in-text callouts to the following references.

Hoffman, F.O., et al. 1990. Preliminary Screening of Contaminants in the Off-Site Surface Water Environment Downstream of the U.S. Department of Energy ORR, ORNL/ER-9. ESD 3485.

Suter, G.W. 1990. Screening Level Risk Assessment for Off-Site Ecological Effects in Surface Waters Downstream from the U.S. Department of Energy ORR, ORNL/ER-8. ESD 3483.

Wilcox, 1983. **[Author of Y-12 section in Chapter 3: please provide reference information.]**

Appendix

ACTIVITY DATA SHEET REFERENCE LIST (ALL PLANTS OR PROGRAMS)

East Fork Poplar Creek (Bill Lawrence/W. Tolbert)

Clinch River (Bruce Kimmel/Mark Bevelhimer)
413-CD Off-Site Investgiations

Y-12 Decontamination and Decommissioning
222-G1 Decontamination and Decommissioning
253-G1 Decontamination and Decommissioning, Building 9202
254-G1 Surveillance and Maintenance, Building 9201-4
255 Surveillance and Maintenance, Buildings 9201-2, 9731, and 9202

Y-12 Remedial Action
209-G1 EFPC Activities—Assessment
209-G2 EFPC Activities—Remediation
279 Upper EFPC Watershed Assessments
280 EFPC—Remediation

K-25 Decontamination and Decommissioning

K-25 Remedial Action
411-CD
411-EW

ORNL Decontamination and Decommissioning

ORNL Remedial Action

Biomonitoring

Technology